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OF THE

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OF

NEW SOUTH WALES

FOR

1917.

(INCORPORATED 1881.)

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1917.

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VOLUME LI.

NOTICE.

The Royal Society of New South Wales originated in 1821 as the "Philosophical Society of Australasia"; after an interval of inactivity, it was resuscitated in 1850, under the name of the "Australian Philosophical Society," by which title it was known until 1856, when the name was changed to the "Philosophical Society of New South Wales"; in 1866, by the sanction of Her Most Gracious Majesty Queen Victoria, it assumed its present title, and was incorporated by Act of the Parliament of New South Wales in 1881.

TO AUTHORS.

Authors of papers desiring illustrations, are advised to consult the editors (Honorary Secretaries) before preparing their drawings. Unless otherwise specially permitted, such drawings should be carefully executed to a large scale on smooth white Bristol board in intensely black Indian ink, so as to admit of the blocks being prepared directly therefrom, in a form suitable for photographic "process." The size of a full page plate in the Journal is $4\frac{1}{4}$ in. $\times$ $6\frac{3}{4}$ in. The cost of all original drawings, and of colouring plates must be borne by Authors.

ERRATA.

Page 208, line 3, after loss of head, read $= \dfrac{4\,f\,h\,v^2}{2\,g\,d}$

Page 208, line 5, after gravitation constant, read h = depth of bore in feet.

Page 425, lines 4 and 5, for W. 10° N., read W. 10° S.

Page xviii, line 15, after with, read 'contour planes.'

,, xxvii, line 15, for used, read 'seems.'

,, xxviii, line 9, for in, read 'into.'

,, xxx, line 29, for not, read 'no.'

,, xxxi, line 26, after 750, read 'lbs. per square inch.'

,, xxxii, lines 5 and 17, for 1 inch, read 'lineal.'

,, xxxiii, line 15, delete whole line except the word 'the'

PUBLICATIONS.

The following publications of the Society, if in print, can be obtained at the Society's House in Elizabeth-street:—

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Royal Society of New South Wales.

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Prof. W. H. WARREN, LL.D., Wh. S.

FORM OF BEQUEST.

I bequeath the sum of £ . to the ROYAL SOCIETY OF NEW SOUTH WALES, Incorporated by Act of the Parliament of New South Wales in 1881, and I declare that the receipt of the Treasurer for the time being of the said Corporation shall be an effectual discharge for the said Bequest, which I direct to be paid within calendar months after my decease, without any reduction whatsoever, whether on account of Legacy Duty thereon or otherwise, out of such part of my estate as may be lawfully applied for that purpose.

[*Those persons who feel disposed to benefit the Royal Society of New South Wales by Legacies, are recommended to instruct their Solicitors to adopt the above Form of Bequest.*]

NOTICE.

Members are particularly requested to communicate any change of address to the Hon. Secretaries, for which purpose this slip is inserted.

Corrected Address:

Name...

....

Titles, etc..

....

Address..

....

....

Date...........................

To the
Hon. Secretaries,
The Royal Society of N. S. Wales,
5 Elizabeth Street, Sydney.

LIST OF THE MEMBERS

OF THE

Royal Society of New South Wales.

P Members who have contributed papers which have been published in the Society's Transactions or Journal. The numerals indicate the number of such contributions.

‡ Life Members.

Elected.		
1908		Abbott, George Henry, B.A., M.B., Ch.M., Macquarie-street; p.r. 'Cooringa,' 252 Liverpool Road, Summer Hill.
1877	P 5	Abbott, W. E., 'Abbotsford,' Wingen.
1904		Adams, William John, M. I. MECH. E., 175 Clarence-street.
1916		Allen, William John, "Oriel," The Boulevard, Strathfield.
1898		Alexander, Frank Lee, c/o Messrs. Goodlet and Smith Ltd., Cement Works, Granville.
1916		Alexander, James Maclean, M. INST. C.E., 25 O'Connell-street.
1905	P 2	Anderson, Charles, M.A., D.Sc. *Edin.*, Australian Museum, College-street.
1909	P 8	Andrews, E. C., B.A., F.G.S., Geological Surveyor, Department of Mines, Sydney.
1915		Armit, Henry William, M.R.C.S. *Eng.*, L.R.C.P. *Lond.*, 30 – 34 Elizabeth-street.
1878		Backhouse, His Honour Judge A. P., M.A., 'Melita,' Elizabeth Bay.
1894	P 25	Baker, Richard Thomas, F.L.S., Curator, Technological Museum.
1894		‡Balsille, George, 'Lauderdale,' N.E. Valley, Dunedin, N.Z.
1896		Barff, H. E., M.A., Warden of the University of Sydney.
1908	P 1	Barling, John, L.S., 'St. Adrians,' Raglan-street, Mosman.
1895	P 9	Barraclough, S. Henry, B.E., M.M.E., ASSOC. M. INST. C.E., M. I. MECH. E., Memb. Soc. Promotion Eng. Education; Memb. Internat. Assoc. Testing Materials; Professor of Mechanical Engineering in the University of Sydney; p.r. 'Marmion,' Victoria-street, Lewisham.
1906		Basnett, Nathaniel James, Punch-st., Mosman.
1894		Baxter, William Howe, L.S., Chief Surveyor, Existing Lines Office, Railway Department, Bridge-street.
1877		Belfield, Algernon H., 'Eversleigh,' Dumaresq.
1909	P 2	Benson, William Noel, D.Sc. *Syd.*, B.A. *Cantab.*, F.G.S., Professor of Geology, The University of Otago, Dunedin, N.Z.
1916		Birrell, Septimus, "Florella," Dunslaffnace-st., Hurlstone Park.
1913		Bishop, Joseph Eldred, Killarney-street, Mosman.
1915		Bishop, John, 24 Bond-street.
1905		Blakemore, George Henry, 4 Bridge-street.
1888		‡Blaxland, Walter, F.R.C.S. *Eng.*, L.R.C.P. *Lond.*, No. 4 A. G. Hospital, Randwick.
1893		Blomfield, Charles E., B.C.E. *Melb.*, 'Woombi,' Kangaroo Camp, Guyra.

Elected		
1898		Blunno, Michele, Licentiate in Science (Rome), 'Havilah,' No. 1, Darlinghurst Road, Darlinghurst.
1907		Bogenrieder, Charles, M.A., No. 2 Little's Avenue, Balmain.
1879		‡Bond, Albert, Wentworth Court, Elizabeth-street.
1917		Bond, Robert Henry, 'Tiro-Tiro,' Middleton-street, Stanmore.
1910		Bradley, Clement Henry Burton, M.B., Ch.M., D.P.H., Department of Public Health, Brisbane.
1876		Brady, Andrew John, L.K. and Q.C.P. *Irel.*, L.R.C.S. *Irel.*, 175 Macquarie-street, Sydney.
1916		Bragg, James Wood, B.A., c/o Gibson, Battle &Co. Ltd.,Kent-st.
1917		Breakwell, Ernest, B.A., B.Sc., Government Agrostologist, Botanic Gardens, Sydney.
1891		Brennand, Henry J. W., B.A., M.B., Ch.M. *Syd.*, c/o H.M.A. Naval Establishments, Garden Island, Sydney; p.r. 'Wobun,' 310 Miller-st., North Sydney.
1914		Broad, Edmund F., 'Cobham,' Woolwich Road, Hunter's Hill.
1878		‡Brooks, Joseph, J.P. L.S., F.R.A.S., F.R.G.S., 'Hope Bank,' Nelson-street, Woollahra.
1913	P 1	Browne, William Rowan, B.Sc., Assistant Lecturer and Demonstrator in Geology in the University, Sydney.
1906		Brown, James B., Resident Master, Technical School, Granville; p.r. 'Aberdour,' Daniel-street, Granville.
1898		‡Burfitt, W. Fitzmaurice, B.A., B.Sc., M.B., Ch.M. *Syd.*, 'Wyoming,' 175 Macquarie-street, Sydney.
1890		Burne, Alfred, D.D.S., Buckland Chambers, 183 Liverpool-st.
1907		Burrows, Thomas Edward, M. INST. C.E., L.S., Metropolitan Engineer, Public Works Department; p.r. 'Balboa,' Fern-street, Randwick.
1909		Calvert, Thomas Copley, ASSOC. M. INST. C.E., Department of Public Works, Sydney.
1904	P 10	Cambage, Richard Hind, L.S., F.L.S., Under Secretary for Mines, Department of Mines, Sydney; p.r. Park Road, Burwood. (President 1912). *Hon. Secretary.*
1907		Campbell, Alfred W., M.D., Ch.M. *Edin.*, 183 Macquarie-street.
1876		Cape, Alfred J., M.A. *Syd.*, 'Karoola,' Edgecliff Road, Edgecliff.
1897	P 4	Cardew, John Haydon, M. INST. C.E., L.S., Commercial Bank of Australia Chambers, George and Margaret-streets.
1891		Carment, David, F.I.A. *Grt. Brit. & Irel.* F.F.A., *Scot.*, 4 Whaling Road, North Sydney.
1909		Carne, Joseph Edmund, F.G.S., Government Geologist, Department of Mines, Sydney.
1917		Carpenter, Frederick Wm., M.A., Senior Science Master, Sydney Grammar School, College-street.
1903	P 2	Carslaw, H. S., M.A., Sc.D., Professor of Mathematics in the University of Sydney.
1913	P 2	Challinor, Richard Westman, F.I.C., F.C.S., Lecturer in Chemistry, Sydney Technical College.
1909	P 2	Chapman, Henry G., M.D., B.S., Professor of Pharmacology in the University of Sydney. *Hon. Treasurer.*
1913	P 7	Cheel, Edwin, Botanical Assistant, Botanic Gardens, Sydney.
1909	P 19	Cleland, John Burton, M.D., Ch.M., Principal Assistant Microbiologist, Department of Public Health, 93 Macquarie-st. *President.*

Elected		
1913	P 1	Cooke, William Ernest, M.A., F.R.A.S., Government Astronomer and Professor of Astronomy in the University of Sydney, The Observatory, Sydney.
1896	P 2	Cook, W. E., M.C.E. *Melb.*, M. INST. C.E., Water and Sewerage Board, North Sydney.
1904	P 2	Cooksey, Thomas, Ph.D., B.Sc. *Lond.*, F.I.C., Government Analyst; p.r. 'Clissold,' Calypso Avenue, Mosman.
1913		Coombs, F. A., F.C.S., Instructor of Leather Dressing and Tanning, Sydney Technical College; p.r. 55 Willoughby Road, North Sydney.
1916		Coote, Edmund James, 492 George-street, Sydney.
1876		Codrington, John Frederick, M.R.C.S. *Eng.*, L.R.C.P. *Lond.* and *Edin*, 'Roseneath,' 8 Wallis-street, Woollahra.
1906		Colley, David John K., Superintendent, Royal Mint, Sydney; p.r. 'Culwalla,' Abbey-street, Leura.
1882		Cornwell, Samuel, J.P., Brunswick Road, Tyagarah.
1909	P 2	Cotton, Leo Arthur, M.A., B.Sc., Assistant Lecturer and Demonstrator in Geology (Acting Professor) in the University of Sydney.
1892	P 1	Cowdery, George R., ASSOC. M. INST. C.E., Blashki Buildings, Hunter-st.; p.r. 'Glencoe,' Torrington Road, Strathfield.
1886		Crago, W. H., M.R.C.S. *Eng.*, L.R.C.P. *Lond.*, 185 Macquarie-st.
1912		Curtis, Louis Albert, L.S., 'Redlands,' Union-street, Mosman.
1875		Dangar, Fred. H., c/o W. G. Deuchar, 12 and 14 Loftus-street.
1890		Dare, Henry Harvey, M.E., M. INST. C.E., Commissioner, Water Conservation and Irrigation Commission, Perpetual Trustee Chambers, Hunter-street, Sydney.
1876	P 3	Darley, Cecil West, M. INST. C.E., Australian Club, Sydney, 'Longheath,' Little Bookham, Surrey, England.
1910		Darnell-Smith, George Percy, B.Sc., F.I.C., F.C.S., Department of Agriculture, Sydney.
1886	P 21	David, T. W. Edgeworth, C.M.G., D.S.O., B.A., D.Sc., F.R.S., F.G.S., Professor of Geology and Physical Geography in the University of Sydney. (President 1895, 1910.)
1909		Davidson, George Frederick.
1892	P 1	Davis, Joseph, M. INST. C.E., 25 O'Connell-street.
1885	P 3	Deane, Henry, M.A., M. INST. C.E., F.L.S., F.R. MET. SOC., F.R.H.S., 'Campsie,' 14 Mercer Road, Malvern, Victoria. (President 1897, 1907.)
1894		Dick, James Adam, B.A. *Syd.*, M.D., Ch.M., F.R.C.S. *Edin.*, 'Catfoss,' Belmore Road, Randwick.
1915	P 1	Dick, Thomas, J.P., Port Macquarie.
1916		Dixon, Jacob Robert L., M.R.C.S., L.R.C.P., The University, Syd.
1906		Dixson, William, 'Merridong,' Gordon Road, Killara.
1876		Docker, His Honour Judge E. B., M.A., 'Mostyn,' Billyard Avenue, Elizabeth Bay.
1913		Dodd, Sydney, D.V.Sc., F.R.C.V.S., Lecturer in Veterinary Pathology in the University of Sydney.
1913	P 2	Doherty, William M., Analyst, Department of Public Health, Sydney.
1908	P 3	Dun, William S., Palæontologist, Department of Mines, Sydney.

Elected		
1916	P 2	Enright, Walter J., B.A., High-street, West Maitland, N.S.W.
1908		Esdaile, Edward William, 54 Hunter-street.
1879	P 4	Etheridge, Robert, Junr., J.P., Curator, Australian Museum; p.r. 'Inglewood,' Colo Vale, N.S.W.
1896		Fairfax, Geoffrey E., *S. M. Herald* Office, Hunter-street.
1868		Fairfax, Sir James R., Knt., *S. M. Herald* Office, Hunter-st.
1887		Faithfull, R. L., M.D., *New York*, L.R.C.P., L.S.A. *Lond.*, 'Wilga,' 18 Wylde-street, Potts Point.
1902		Faithfull, William Percy, Australian Club.
1910		Farrell, John, 68½ Pitt-st.; p.r. 20 Bayswater-rd., Darlinghurst.
1909	P 2	Fawsitt, Charles Edward, D.Sc., Ph.D., Professor of Chemistry in the University of Sydney.
1881		Fiaschi, Thos., M.D., M.Ch., *Pisa*, 129 Phillip-street
1888		Fitzhardinge, His Honour Judge G. H., M.A., 'Red Hill,' Beecroft.
1879		‡Foreman, Joseph, M.R.C.S. *Eng.* L.R.C.P. *Edin.*, 'Wyoming,' Macquarie-street.
1905		Foy, Mark, 'Eumemering,' Bellevue Hill, Woollahra.
1904		Fraser, James, M. INST. C.E., Chief Commissioner for Railways, Bridge-street; p.r. 'Arnprior,' Neutral Bay.
1907		Freeman, William, 'Clodagh,' Beresford Road, Rose Bay.
1899		French, J. Russell, General Manager, Bank of New South Wales, George-street.
1881		Furber, T. F., F.R.A.S., c/o Dr. R. I. Furber, 'Sunnyside,' Stanmore Road, Stanmore.
1917		Galbraith, Augustus Wm., Civil Engineer, Broken Hill, Proprietory Co. Ltd., Box 196 P.O., Newcastle, N.S.W.
1906		Gosche, W. A. Hamilton, 24½ Pitt-street, Sydney.
1897		Gould, Senator The Hon. Sir Albert John, K.B., V.D., 'Eynesbury,' Edgecliff.
1916		Granger, James Darnell, Ph. D., Manager of Chiswick Polish Co. of Australia, Mitchell Road, Alexandria.
1916		Green, Victor Herbert, 7 Bent-street, Sydney.
1899	P 1	Greig-Smith, R., D.Sc. *Edin.*, M.Sc. *Dun.*, Macleay Bacteriologist, Linnean Society's House, Ithaca Road, Elizabeth Bay. (President 1915.) *Vice-President.*
1912		Grieve, Robert Henry, B.A., 'Langtoft,' Llandaff-st., Waverley.
1912		Griffiths, F. Guy, B.A., M.D., Ch M., 135 Macquarie-st., Sydney.
1891	P 16	Guthrie, Frederick B., F.I.C., F.C.S., Chemist, Department of Agriculture, 137 George-street, Sydney. (President 1903).
1880	P 4	Halligan, Gerald H., L.S., F.G.S., 'Riversleigh,' Hunter's Hill.
1912		Hallmann, E. F., B.Sc., Fort Street Boy's High School, Petersham.
1892		Halloran, Henry Ferdinand, L.S., 82 Pitt-street.
1909		Hammond, Walter L., B.Sc., Hurlstone Avenue, Summer Hill.
1916	P 1	Hamilton, Arthur Andrew, Botanical Assistant, Botanic Gardens, Sydney.

Elected		
1912		Hamilton, A. G., Lecturer on Nature Study, Teachers' College, Blackfriars.
1887	P 8	Hamlet, William M., F.I.C., F.C.S., Member of the Society of Public Analysts; 'Glendowan,' Glenbrook, Blue Mountains. (President 1899, 1908).
1916		Hardy, Victor Lawson, 'The Laurel,' 43 Toxteth Rd., Glebe Pt.
1912		Hare, Arthur J., Under Secretary for Lands, 'Booloorool,' Monte Christo-street, Woolwich.
1905	P 2	Harker, George, D.Sc., Assistant Lecturer and Demonstrator in Organic Chemistry in the University of Sydney.
1913	P 1	Harper, Leslie F., F.G.S., Geological Surveyor, Department of Mines, Sydney.
1884	P 1	Haswell, William Aitcheson, M.A., D.Sc., F.R.S., Emeritus Professor of Zoology and Comparative Anatomy in the University of Sydney; p.r. 'Mimihau,' Woollahra Point.
1900		Hawkins, W. E., 88 Pitt-street.
1916		Hay Dalrymple-, Richard T., L.S., Chief Commissioner of Forests, N. S. Wales; p.r. Goodchap Road, Chatswood.
1914		Hector, Alex. Burnet, 481 Kent-street.
1891	P 3	Hedley, Charles, F.L.S., Assistant Curator, Australian Museum, Sydney. *Vice-President.* (President 1914.)
1899		Henderson, J., F.R.E.S., 'Wahnfried,' Drummoyne.
1916		Henderson, James, 'Dunsfold,' Clanalpine-street, Mosman.
1884	P 1	Henson, Joshua B., ASSOC. M. INST. C.E., Hunter District Water Supply and Sewerage Board, Newcastle.
1905		Hill, John Whitmore, 'Bondo,' Western Road, Parramatta.
1892		Hodgson, Charles George, 157 Macquarie-street.
1916		Hoggan, Henry James, Consulting Engineer, 'Lincluden,' Frederick-street, Rockdale.
1901		Holt, Thomas S., 'Amalfi,' Appian Way, Burwood.
1905		Hooper, George, Assistant Superintendent, Sydney Technical College; p.r. 'Branksome,' Henson-street, Summer Hill.
1891	P 3	Houghton, Thos. Harry, M. INST. C.E., M. I. MECH. E., 63 Pitt-st. (President 1916), *Vice-President.*
1906		Howle, Walter Cresswell, L.S.A. *Lond.*, Bradley's Head Road, Mosman.
1913		Hudson, G. Inglis, J.P., 'Gudvangen,' Arden-street, Coogee.
1917		Hurse, Alfred Edward, A.M.I.C.E., 'Llanfair,' Robert-street, Strathfield.
1904		Jaquet, John Blockley, A.R.S.M., F.G.S., Chief Inspector of Mines, Department of Mines, Sydney.
1905	P 8	Jensen, Harold Ingemann, D.Sc., Treasury Chambers, George-street, Brisbane.
1917		Jenkins, Richard Ford, Engineer for Boring, Irrigation Commission, 6 Union-street, Mosman.
1916	P 1	Johnston, Stephen Jason, B.A., D.Sc., Professor of Zoology in the
1907		University of Sydney.
1909	P 13	Johnston, Thomas Harvey, M.A., D.Sc., F.L.S., Lecturer in Biology in the University of Queensland, Brisbane.
1867		Jones, Sir P. Sydney, Knt., M.D. *Lond.*, F.R.C.S. *Eng.*, 'Llandilo,' Boulevarde, Strathfield.
1911		Julius, George A., B.Sc., M.E., M. I. MECH. E., Culwulla Chambers, Castlereagh-street, Sydney.

Elected		
1907		Kaleski, Robert, Holdsworthy, Liverpool.
1883		Kater, The Hon. H. E., J.P., M.L.C., Australian Club.
1873	P 4	Keele, Thomas William, L.S., M. INST. C.E., Commissioner, Sydney Harbour Trust, Circular Quay; p.r. Llandaff-st., Waverley.
1914		Kemp, William E., A.M. INST. C.E., Public Works Department, Coff's Harbour Jetty.
1887		Kent, Harry C., M.A., F.R.I.B.A., Dibbs' Chambers, Pitt-street.
1901		Kidd, Hector, M. INST. C.E., M. I. MECH. E., Cremorne Road, Cremorne.
1896		King, Kelso, 120 Pitt-street.
1878		Knaggs, Samuel T., M.D. *Aberdeen*, F.R.C.S. *Irel.*, 'Northcote,' Sir Thomas Mitchell Road, Bondi.
1881	P 23	Knibbs, G. H., C.M.G., F.S.S., F.R.A.S., L.S., Member Internat. Assoc. Testing Materials; Memb. Brit. Sc. Guild; Commonwealth Statistician, Melbourne; p.r. 'Normanhurst,' Denmark-st., Kew, Victoria. (President 1898.)
1877		Knox, Edward W., 'Rona,' Bellevue Hill, Double Bay.
1911	P 2	Laseron, Charles Francis, Technological Museum.
1913		Lawson, A. Anstruther, D.Sc., F.R.S.E., F.L.S., Professor of Botany in the University of Sydney.
1916		L'Estrange, Walter William, 55 Albert Road, Homebush.
1906		Lee, Alfred, 'Glen Roona,' Penkivil-street, Bondi.
1909		Leverrier, Frank, B.A., B.Sc., K.C., 182 Phillip-street.
1883		Lingen, J. T., M.A. *Cantab.*, University Chambers, 167 Phillip-street, Sydney.
1906		Loney, Charles Augustus Luxton, M. AM. SOC. REFR. E., Equitable Building, George-street.
1884		MacCormick, Sir Alexander, M.D., C.M. *Edin.*, M.R.C.S. *Eng.*, 185 Macquarie-street, North.
1887		MacCulloch, Stanhope H., M.B., Ch.M. *Edin.*, 24 College-street.
1878		MacDonald, Ebenezer, J.P., c/o Perpetual Trustee Co., Ld., Hunter-street, Sydney.
1876		Mackellar, The Hon. Sir Charles Kinnaird, K.C.M.G., M.L.C., M.B., C.M. *Glas.*, Equitable Building, George-street.
1912	P 1	MacKinnon, Ewen, B.Sc., Agricultural Museum, George-st. N.
1899		MacTaggart, J. N. C., M.E. *Syd.*, ASSOC. M. INST. C.E., Water and Sewerage Board District Office, Lyons Road, Drummoyne.
1903		McDonald, Robert, J.P., L.S., Pastoral Chambers, O'Connell-st.; p.r. 'Lowlands,' William-street, Double Bay,
1891		McDouall, Herbert Crichton, M.R.C.S. *Eng.*, L.R.C.S. *Lond.*, D.P.H. *Cantab.*, Hospital for the Insane, Gladesville.
1906		McIntosh, Arthur Marshall, 'Glenbourne,' Hill-st., Roseville.
1891	P 2	McKay, R. T., L.S., ASSOC. M. INST. C.E., Geelong Waterworks and Sewerage Trusts Office, Geelong, Victoria.
1880	P 9	McKinney, Hugh Giffin, M.E., Roy. Univ. *Irel.*, M. INST. C.E., Sydney Safe Deposit, Paling's Buildings, Ash-street.
1917		McLean, Archibald Lang, M.D., CH.M., B.A., c/o Bank of New South Wales, 29 Threadneedle-street, London, E.C.
1901	P 1	McMaster, Colin J., L.S., Chief Commissioner of Western Lands; p.r. Wyuna Road, Woollahra Point.

Elected		
1894		McMillan, Sir William, K.C.M.G., 'Althorne,' Edgecliff Road, Woollahra.
1916		McQuiggin, Harold G., B.Sc., Lecturer and Demonstrator in Physiology in the University of Sydney; p.r. 'Berolyn,' Beaufort-street, Croydon.
1909		Madsen, John Percival Vissing, D.Sc., B.E., P. N. Russell Lecturer in Electrical Engineering in the University of Sydney.
1883	P 32	Maiden, J. Henry, J.P., I.S.O., F.R.S., F.L.S., F.R.H.S., Hon. Fellow Roy. Soc. S.A.; Hon. Memb. Roy. Soc, W.A.; Netherlands Soc.for Promotion of Industry; Philadelphia College Pharm. Southern Californian Academy of Sciences; Pharm. Soc. N.S.W.; Brit. Pharm. Conf.; Corr. Fellow Therapeutical Soc., Lond.; Corr. Memb. Pharm. Society Great Britain; Bot. Soc. Edin.; Soc. Nat. de Agricultura (Chile); Soc. d'Horticulture d'Alger; Union Agricole Calédonienne; Soc. Nat. etc., de Chérbourg; Roy. Soc. Tas.; Roy. Soc. Queensl.; Inst. Nat. Genévois; Hon. Vice-Pres. of the Forestry Society of California; Diplomé of the Société Nationale d'Acclimatation de France; Linnean Medallist, Linnean Society; N.S.W. Govt. Rep. of the "Commission Consultative pour la Protection Internat. de la Nature"; Government Botanist and Director, Botanic Gardens, Sydney. *Hon. Secretary.* (President 1896, 1911.)
1880	P 1	Manfred, Edmund C., Montague-street, Goulburn.
1897		Marden, John, M.A., LL.D., Principal, Presbyterian Ladies' College, Croydon, Sydney.
1908		Marshall, Frank, B.D.S. *Syd.*, 'Beanbah,' 235 Macquarie-street.
1914		Martin, A. H., 'Ruthven,' Eric-street, Artarmon.
1875	P 28	Mathews, Robert Hamilton, L.S., Assoc. Etran. Soc. d' Anthrop. de Paris; Cor. Mem. Anthrop. Soc., Washington, U.S.A.; Corr. Mem. Anthrop. Soc. Vienna; Corr. Mem. Roy. Geog. Soc. Aust. Q'sland; Local Correspondent Roy. Anthrop. Inst., Lond.; 'Carcuron,' Hassall-st., Parramatta.
1903		Meggitt, Loxley.
1912		Meldrum, Henry John, p.r. 'Craig Roy,' Sydney Rd., Manly.
1905		Miller, James Edward, Broken Hill, New South Wales.
1889	P 8	Mingaye, John C. H., F.I.C., F.C.S., Assayer and Analyst to the Department of Mines; p.r. Campbell-street, Parramatta.
1879		Moore, Frederick H., Union Club, Sydney, c/o Dalgety's Ltd., London.
1879		Mullins, John Francis Lane, M.A. *Syd.*, 'Killountan,' Darling Point.
1915		Murphy, R. K., Dr. Ing., Chem. Eng., Consulting Chemical Engineer and Lecturer in Chemistry, Technical College, Sydney.
1876		Myles, Charles Henry, 'Dingadee,' Everton Rd., Strathfield.
1893	P 3	Nangle, James, F.R.A.S., Superintendent of Technical Education, The Technical College, Sydney; p.r. 'St. Elmo,' Tupper-street, Marrickville.
1917		Nash, Norman C., Analytical Chemist, 'Treleaven,' Darling-street, Balmain East.
1891		‡Noble, Edward George, L.S., 8 Louisa Road, Balmain.
1893		Noyes, Edward, ASSOC. INST. C.E., ASSOC. I. MECH. E., c/o Messrs. Noyes Bros., 115 Clarence-street, Sydney.

Elected		
1903		‡Old, Richard, 'Waverton,' Bay Road, North Sydney.
1913		Ollé, A. D., F.C.S., 'Kareema,' Charlotte-street, Ashfield.
1896		Onslow, Col. James William Macarthur, 'Gilbulla,' Menangle.
1875		O'Reilly, W. W. J., M.D., Ch.M. Q. Univ. *Irel.*, M.R.C.S. *Eng.*, 171 Liverpool-street, Hyde Park.
1917		Ormsby, Irwin, 'Caleula,' Allison Road, Randwick.
1891		Osborn, A. F., ASSOC. M. INST. C.E., Water Supply Branch, Sydney, 'Uplands,' Meadow Bank, N.S.W.
1880		Palmer, Joseph, 96 Pitt-st.; p.r. Kenneth-st., Willoughby.
1916		Parker, Philip ā Morley, M. INST. C E., M. AM. SOC. C.E., B.C.E., B.A., Rawson Chambers, Pitt and Eddy-streets, Sydney.
1878		Paterson, Hugh, 183 Liverpool-street, Hyde Park.
1901		Peake, Algernon, M. INST. C.E., L.S., Prospect Rd., Summer Hill.
1899		Pearse, W., Union Club; p.r. 'Plashett,' Jerry's Plains, viâ Singleton.
1877		Pedley, Perceval R., Lord Howe Island.
1899		Peterson, T. Tyndall, F.C.P.A., Remington Chambers, 86 Pitt-st.
1909	P 2	Pigot, Rev. Edward F., S.J., B.A., M.B. *Dub.*, Director of the Seismological Observatory, St. Ignatius' College, Riverview.
1879	P 8	Pittman, Edward F., ASSOC. R.S.M., L.S., 'The Oaks,' 65 Park-street, South Yarra, Victoria.
1881		Poate, Frederick, L.S., 'Clanfield,' 50 Penkivil-street, Bondi.
1879		Pockley, Thomas F. G., Union Club, Sydney.
1887	P 10	Pollock, J. A., D.Sc., F.R.S., Corr. Memb. Roy. Soc. Tasmania; Roy. Soc. Queensland; Professor of Physics in the University of Sydney.
1917		Poole, William, B.E., A.M. INST. C.E., L.S., 906 Culwulla Chambers, Castlereagh-street.
1896		Pope, Roland James, B.A., *Syd.*, M.D., C.M., F.R.C.S., *Edin.*, 183 Macquarie-street.
1910		Potts, Henry William, F.L.S., F.C.S., Principal, Hawkesbury Agricultural College, Richmond, N.S.W.
1914		Purdy, John Smith, D.S.O., M.D., C.M. *Aberd.*, D.P.H. *Camb.*, Metropolitan Medical Officer of Health, Town Hall, Sydney.
1893		Purser, Cecil, B.A., M.B., Ch.M. *Syd.*, 193 Macquarie-street.
1876	P 1	Quaife, F. H., M.A., M.D., M.S, 'Yirrimbirri,' Stanhope Road, Killara.
1912	P 2	Radcliff, Sidney, F.C.S., B.M.A. Building, 30 Elizabeth-street.
1890	P 1	Rae, J. L. C., 'Lisgar,' King-street, Newcastle.
1916	P 1	Read, John, M.A., Ph.D., B.Sc., Professor of Organic Chemistry in the University of Sydney.
1914		Rhodes, Thomas, Civil Engineer, Box 109, Post Office, Broken Hill.
1909		Reid, David, 'Holmsdale,' Pymble.
1902		Richards, G. A., Mount Morgan Gold Mining Co., Mount Morgan, Queensland.

Elected		
1906		Richardson, H. G. V.
1913	P 2	Robinson, Robert, D.Sc., The University, Liverpool, England.
1915		Ross, A. Clunies, B.Sc., C. of E. Grammar School, North Sydney.
1913		Roseby, Rev. Thomas, M.A., LL.D. *Syd.*, F.R.A.S., 'Tintern,' Mosman.
1884		Ross, Chisholm, M.D. *Syd.*, M.B., C.M. *Edin.*, 151 Macquarie-st.
1895	P 1	Ross, Herbert E., Equitable Building, George-street.
1897		Russell, Harry Ambrose, B.A., c/o Messrs. Sly and Russell, 369 George-street; p.r. 'Mahuru,' Fairfax Road, Bellevue Hill.
1893		Rygate, Philip W., M.A., B.E. *Syd.*, ASSOC. M. INST. C.E., L.S., City Bank Chambers, Pitt-street, Sydney.
1915		Sach, A. J., F.C.S., 'Kelvedon,' North Road, Ryde.
1917		Sawkins, Dansie T., M.A., Trigonometrical Surveyor, "Brymedura,' Kissing Point Road, Turramurra.
1913		Scammell, W. J., Mem. Pharm. Soc. *Grt. Brit.*, 18 Middle Head Road, Mosman.
1892	P 1	Schofield, James Alexander, F.C.S., A.R.S.M., Assistant Professor of Chemistry in the University of Sydney.
1904	P 1	Sellors, Richard P., B.A. *Syd.*, 'Mayfield,' Wentworthville.
1883	P 4	Shellshear, Walter, M. INST. C.E., Consulting Engineer for N. S. Wales, 64 Victoria-street, Westminster, London.
1917		Sibley, Samuel Edward, Chemist, 'Garnella,' Blenheim-street, Randwick.
1900		Simpson, R. C., Technical College, Sydney.
1910		Simpson, William Walker, 'Abbotsford,' Leichhardt-street, Waverley.
1882		Sinclair, Eric, M.D., C.M. *Glas.*, Inspector-General of Insane, 9 Richmond Terrace, Domain; p.r. 'Broomage,' Kangaroo-street, Manly.
1891	P 3	Smail, J. M., M. INST. C.E., Chief Engineer, Metropolitan Board of Water Supply and Sewerage, 341 Pitt-street.
1912		Smart, Bertram James, B.Sc., Public Works Department, Sydney
1893	P 53	Smith, Henry G., F.C.S., Assistant Curator, Technological Museum, Sydney. *Vice-President.* (President 1913.)
1874	P 1	‡Smith, John McGarvie, 89 Denison-street, Woollahra.
1916		Smith, Stephen Henry, Department of Education, Sydney.
1917		Spruson, Wilfred Joseph, Consulting Engineer and Patent Attorney, 91 Elizabeth-street.
1892	P 2	Statham, Edwyn Joseph, ASSOC. M. INST. C.E., Cumberland Heights, Parramatta.
1916		Stephen, Alfred Ernest, Culwulla Chambers, 67 Castlereagh-street, Sydney.
1914		Stephens, Frederick G. N., F.R.C.S., M.B., Ch.M., 'Gleneugie,' New South Head Road, Rose Bay.
1913		Stewart, Alex. Hay, B.E., Metallurgist, Technical College, Sydney.
1900		Stewart, J. Douglas, B.V.Sc., M.R.C.V.S., Professor of Veterinary Science in the University of Sydney; 'Berelle,' Homebush Road, Strathfield.
1903		Stoddart, Rev. A. G., The Rectory, Manly.

Elected		
1909		Stokes, Edward Sutherland, M.B. *Syd.*, F.R.C.P. *Irel.*, Medical Officer, Metropolitan Board of Water Supply and Sewerage, 341 Pitt-street.
1916	P 1	Stone, W. G., Assistant Analyst, Department of Mines, Sydney.
1883	P 4	Stuart, Sir Thomas P. Anderson, M.D., Ch.M., LL.D. *Edin.*, D.Sc., Professor of Physiology in the University of Sydney; p.r. 'Lincluden,' Fairfax Road, Double Bay. (President 1893, 1906.)
1901	P 7	Süssmilch, C. A., F.G.S., Technical College, Newcastle, N.S.W.
1912		Swain, E. H. F., Forestry Department, Brisbane.
1917		Tate, Herbert, Bridge Road, Stanmore.
1915	P 1	Taylor, Harold B., B.Sc., Kenneth-street, Longueville.
1906		Taylor, Horace, Registrar, Dental Board, 7 Richmond Terrace, Domain,
1905		Taylor, John M., M.A., LL.B. *Syd.*, 'Woonona,' 43 East Crescent-street, McMahon's Point, North Sydney.
1893		‡Taylor, James, B.Sc, A.R.S.M. 'Cartref,' Brierly-st., Mosman.
1899		Teece, R., F.I.A., F.F.A., Wolesly Road, Point Piper.
1878		Thomas, F. J., 'Lovat,' Nelson-street, Woollahra.
1879		Thomson, The Hon. Dugald, Carrabella-st., North Sydney.
1913		Thompson, Joseph, M.A., LL.B., Vickery's Chambers, 82 Pitt-street, Sydney.
1913		Tietkens, William Harry, 'Upna,' Eastwood.
1916		Tilley, Cecil E., Demonstrator in Geology, The University, Sydney.
1916		Tillyard, Robin John, M.A., B.Sc., F.E.S., 'Kuranda,' Mount Errington. Hornsby, N.S.W.
1879		‡Trebeck, P. C., Orange, N.S.W.
1900		Turner, Basil W., A.R.S.M., F.C.S., Victoria Chambers, 83 Pitt-st.
1913		Ullrich, Richard Emil, Accountant, 43 Bond-street, Mosman.
1916		Valder, George, J.P., Under Secretary and Director, Department of Agriculture, Sydney.
1883		Vause, Arthur John, M.B., C.M. *Edin.*, 'Bay View House,' Tempe.
1890		Vicars, James, M.E., Memb. Intern. Assoc. Testing Materials; Memb. B. S. Guild; Challis House, Martin Place.
1892		Vickery, George B., 78 Pitt-street.
1903	P 3	Vonwiller, Oscar U., B.Sc., Assistant Professor of Physics in the University of Sydney. (Acting Professor.)
1879		Walker, H. O., Commercial Union Assurance Co., Pitt-street.
1899		‡Walker, The Hon. J. T., F.R.C.I., Fellow of Institute of Bankers *Eng.*, 'Wallaroy,' Edgecliff Road, Woollahra.
1910		Walker, Charles, 'Lynwood,' Terry Road, Ryde.
1910		Walker, Harold Hutchison, Major, C.M.F., Vickery's Chambers, 82 Pitt-street.
1901		Walkom, A. J., A.M.I.E.E., Electrical Branch, G.P.O., Sydney.
1917		Wallas, Thomas Irwin, Bacteriologist, 175 Macquarie-street.

Elected		
1891	P 2	Walsh, Henry Deane, B.A.I. *Dub.*, M. INST. C.E., Commissioner and Engineer-in-Chief, Harbour Trust, Circular Quay. (President 1909.)
1903		Walsh, Fred., J.P., Capt. C.M.F., Consul-General for Honduras in Australia and New Zealand; For. Memb. Inst. Patent Agents, London; Patent Attorney Regd. U.S.A.; Memb. Patent Law Assoc., Washington; Regd. Patent Attorn. Comm. of Aust; Memb. Patent Attorney Exam. Board Aust.; George and Wynyard-streets; p.r. 'Walsholme,' Centennial Park, Sydney.
1901		Walton, R. H., F.C.S., 'Flinders,' Martin's Avenue, Bondi.
1916		Warden, Robert Alexander, President, Government Savings Bank, N.S.W., Moore-street, Sydney.
1913	P 4	Wardlaw, Hy. Sloane Halcro, D.Sc. *Syd.*, 87 Macpherson-street, Waverley.
1883	P 17	Warren, W. H., LL.D., WH. SC., M. INST. C.E., M. AM. SOC. C.E., Member of Council of the International Assoc. for Testing Materials, Professor of Engineering in the University of Sydney. (President 1892, 1902.)
1876		Watkins, John Leo, B.A. *Cantab.*, M.A. *Syd.*, Parliamentary Draftsman, Attorney General's Department, Macquarie-st.
1910		Watson, James Frederick, M.B., Ch.M., Australian Club, Sydney, p.r. 'Midhurst,' Woollahra.
1911		Watt, R. D., M.A., B.Sc., Professor of Agriculture in the University of Sydney.
1915	P 4	Watts, Rev. W. Walter, 'The Manse,' Wycheproof, Victoria.
1910	P 1	Wearne, Richard Arthur, B.A., Principal, Technical College, Ipswich, Queensland.
1897		Webb, Frederick William, C.M.G., J.P., 'Livadia,' Manly.
1892		Webster, James Philip, ASSOC. M. INST. C.E., L.S., *New Zealand*, 'Tantallon, Middleton-street, Stanmore.
1907		Welch, William, F.R.G.S., 'Roto-iti,' Boyle-street, Mosman.
1881		‡Wesley, W. H., London.
1892		White, Harold Pogson, F.C.S., Assistant Assayer and Analyst, Department of Mines; p.r. 'Quantox,' Park Road, Auburn.
1877		‡White, Rev. W. Moore, A.M., LL.D. *Dub.*
1909		White, Charles Josiah, B.Sc., Science Lecturer, Sydney Training College; p.r. 'Byrntryird,' Prospect Rd. Summer Hill.
1917		Willington, William Thos., King-street, Arncliff.
1908	P 1	Willis, Charles Savill, M.B., Ch.M. *Syd.*, M.R.C.S. *Eng.*, L.R.C.P. *Lond.*, D.P.H., *Lond.*, Department of Public Instruction, Bridge-street.
1890		Wilson, James T., M.B., Ch.M. *Edin.*, F.R.S., Professor of Anatomy in the University of Sydney.
1891		Wood, Percy Moore, L.R.C.P. *Lond.*, M.R.C.S. *Eng.*, 'Redcliffe,' Liverpool Road, Ashfield.
1906	P 6	Woolnough, Walter George, D.Sc., F.G.S., Professor of Geology in the University of Western Australia, Perth.
1916		Wright, Gilbert, Lecturer and Demonstrator in Agricultural Chemistry, Department of Agriculture, The University, Sydney.
1917		Wright, George, c/o Farmer & Company, Pitt-street.
1916		Youll, John Gibson, Perpetual Trustee Chambers, Hunter-st.

Elected		HONORARY MEMBERS.
		Limited to Twenty.
		M.—Recipients of the Clarke Medal.
1914		Bateson, W. H., M.A., F.R.S., Director of the John Innes Horticultural Institution, England, The Manor House, Merton, Surrey, England.
1900		Crookes, Sir William, Kt., O.M., LL.D., D.Sc., F.R.S., 7 Kensington Park Gardens, London W.
1911		Hemsley, W. Botting, LL.D. (*Aberdeen*), F.R.S., F.L.S., V.M.H., Formerly Keeper of the Herbarium, Royal Gardens, Kew; Korresp. Mitgl. der Deutschen Bot. Gesellschaft; Hon. Memb. Sociedad Mexicana de Historia Natural; New Zealand Institute; Roy. Hort. Soc. London; 5 Southview, Henfield, Sussex, England.
1914		Hill, J. P., D.Sc., F.R.S., Professor of Zoology, University College, London.
1908		Kennedy, Sir Alex. B. W., Kt., LL.D., D. ENG., F.R.S., Emeritus Professor of Engineering in University College, London, 17 Victoria-street, Westminster, London S.W.
1908	P 57	*Liversidge, Archibald, M.A., LL.D., F.R.S., Emeritus Professor of Chemistry in the University of Sydney, 'Fieldhead,' George Road, Coombe Warren, Kingston, Surrey, England. (President 1889, 1900.)
1915		Maitland, Andrew Gibb, F.G.S., Government Geologist of Western Australia.
1912		Martin, C. J., D.Sc., F.R.S., Director of the Lister Institute of Preventive Medicine, Chelsea Gardens, Chelsea Bridge Road, London.
1894		Spencer, Sir W. Baldwin, K.C.M.G., M.A., D.Sc., F.R.S., Professor of Biology in the University of Melbourne.
1900		Thiselton-Dyer, Sir William Turner, K.C.M.G., C.I.E., M.A., LL.D., Sc.D., F.R.S., The Ferns, Witcombe, Gloucester, England.
1915	M	Thomson, Sir J. J., O.M., D.Sc., F.R.S., Nobel Laureate, Cavendish Professor of Experimental Physics in the University Cambridge, Trinity College, Cambridge, England.

* Retains the rights of ordinary membership. Elected 1872.

OBITUARY 1917-18.

Ordinary Members.

1875	Dixon, W. A.
1916	Loubét, P. R.
1903	McLaughlin, J.
1916	Milne, E.

AWARDS OF THE CLARKE MEDAL.

Established in memory of

THE REVD. W. B. CLARKE, M.A., F.R.S., F.G.S., etc.,

Vice-President from 1866 *to* 1878.

To be awarded from time to time for meritorious contributions to the Geology, Mineralogy, or Natural History of Australia. The prefix * indicates the decease of the recipient.

Awarded

1878 *Professor Sir Richard Owen, K.C.B., F.R.S.

1879 *George Bentham, C.M.G., F.R.S.

1880 *Professor Thos. Huxley, F.R.S.

1881 *Professor F. M'Coy, F.R.S., F.G.S.

1882 *Professor James Dwight Dana, LL.D.

1883 *Baron Ferdinand von Mueller, K.C.M.G., M.D., Ph.D., F.R.S., F.L.S.

1884 *Alfred R. C. Selwyn, LL.D., F.R.S., F.G.S.

1885 *Sir Joseph Dalton Hooker, O.M., G.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

1886 *Professor L. G. De Koninck, M.D., University of Liège.

1887 *Sir James Hector, K.C.M.G., M.D., F.R.S.

1888 *Rev. Julian E. Tenison-Woods, F.G.S., F.L.S.

1889 *Robert Lewis John Ellery, F.R.S., F.R.A.S.

1890 *George Bennett, M.D., F.R.C.S. *Eng.*, F.L.S., F.Z.S.

1891 *Captain Frederick Wollaston Hutton, F.R.S., F.G.S.

1892 Sir William Turner Thiselton Dyer, K.C.M.G., C.I.E., M.A., LL.D., Sc. D., F.R.S., F.L.S., late Director, Royal Gardens, Kew.

1893 *Professor Ralph Tate, F.L.S., F.G.S.

1895 Robert Logan Jack, F.G.S., F.R.G.S., late Government Geologist, Brisbane, Queensland.

1895 Robert Etheridge, Junr., Curator of the Australian Museum, Sydney.

1896 *The Hon. Augustus Charles Gregory, C.M.G., F.R.G.S.

1900 *Sir John Murray, K.C.B., LL.D., Sc. D., F.R.S.

1901 *Edward John Eyre.

1902 *F. Manson Bailey, C.M.G., F.L.S.

1903 *Alfred William Howitt, D.Sc., F.G.S.

1907 Walter Howchin, F.G.S., University of Adelaide.

1909 Dr. Walter E. Roth, B.A., Pomeroon River, British Guiana, South America.

1912 W. H. Twelvetrees, F.G.S., Government Geologist. Launceston, Tasmania.

1914 A. Smith Woodward, LL.D., F.R.S., Keeper of Geology, British Museum (Natural History) London.

1915 Professor W. A. Haswell, M.A., D.Sc., F.R.S., The University, Sydney.

1917 Professor T. W. E. David, C.M.G., B.A., D.Sc., F.R.S., F.G.S., The University, Sydney.

AWARDS OF THE SOCIETY'S MEDAL AND MONEY PRIZE.

Money Prize of £25.

Awarded.

1882 John Fraser, B.A., West Maitland, for paper entitled 'The Aborigines of New South Wales.'

1882 Andrew Ross, M.D., Molong, for paper entitled 'Influence of the Australian climate and pastures upon the growth of wool.'

The Society's Bronze Medal and £25.

1884 W. E. Abbott, Wingen, for paper entitled 'Water supply in the Interior of New South Wales.'

1886 S. H. Cox, F.G.S., F.C.S., Sydney, for paper entitled 'The Tin deposits of New South Wales.'

1887 Jonathan Seaver, F.G.S., Sydney, for paper entitled 'Origin and mode of occurrence of gold-bearing veins and of the associated Minerals.'

1888 Rev. J. E. Tenison-Woods, F.G.S., F.L.S., Sydney, for paper entitled 'The Anatomy and Life-history of Mollusca peculiar to Australia.'

1889 Thomas Whitelegge, F.R.M.S., Sydney, for paper entitled 'List of the Marine and Fresh-water Invertebrate Fauna of Port Jackson and Neighbourhood.'

1889 Rev. John Mathew, M.A., Coburg, Victoria, for paper entitled 'The Australian Aborigines.'

1891 Rev. J. Milne Curran, F.G.S., Sydney, for paper entitled 'The Microscopic Structure of Australian Rocks.'

1892 Alexander G. Hamilton, Public School, Mount Kembla, for paper entitled 'The effect which settlement in Australia has produced upon Indigenous Vegetation.'

1894 J. V. De Coque, Sydney, for paper entitled the 'Timbers of New South Wales.'

1894 R. H. Mathews, L.S., Parramatta, for paper entitled 'The Aboriginal Rock Carvings and Paintings in New South Wales.'

1895 C. J. Martin, D.Sc., M.B., F.R.S., Sydney, for paper entitled 'The physiological action of the venom of the Australian black snake (*Pseudechis porphyriacus*).'

1896 Rev. J. Milne Curran, Sydney, for paper entitled 'The occurrence of Precious Stones in New South Wales, with a description of the Deposits in which they are found.'

PRESIDENTIAL ADDRESS.

By T. H. HOUGHTON, M. Inst. C.E.

[Delivered to the Royal Society of N.S. Wales, May 2, 1917.]

THE great war, which the Empire and our Allies are fighting for the freedom of the world, has been raging for nearly three years, and is now being conducted more fiercely than ever, is uppermost in the thoughts of us all, and has been brought very near to us by the losses of brave sons or relatives which so many have suffered. Our sincerest sympathy is with them, and we look forward to a long period of peace and freedom when science will be devoted, not to devising the best means of destroying mankind, but to the development of our natural resources and all that is best in humanity. The cabled report of Mr. Bonar Law's speech in the House of Commons recently, in which he said that "he believed the long night of sorrow and anguish which had desolated the world was drawing to a close," has a special significance, and is, we trust, a forerunner of the joyful announcement that a termination of fighting is about to be reached.

Since the battle of the Falkland Islands and the destruction of the "Emden," Australia has not been in immediate danger of attack, and the horrors of war have not been brought home to us as vividly as to those nearer the scene of battle, but now that our brave lads are returning broken down in health and maimed, we begin to realise more fully the sacrifice that so many have made at the call of duty, and I am sure that it is not only the wish but the determination of every Briton, whether in the Mother Land or the Dominions beyond the Seas, that those who have fought so bravely and so well, and have come back

unable to earn their living, shall be well cared for since the debt we owe to them is one we never can fully repay.

Few of our members are fit and free to go, but such as could do so offered their services; two will not return, Colonel Onslow Thompson and Colonel Flashman. Major Professor David, although of an age that would in most cases prevent a less determined man volunteering, did not hesitate to offer his valuable services when he found that they would be of use to his country; he has run great risks and for a time was in a critical state, the result of an accident which happened to him when carrying out his duty, but I am pleased to say he has happily recovered and is again at work.

Captain Professor Pollock is doing important work at the front, and by last accounts was enjoying good health.

Notwithstanding the war, the Society has had a very successful year; nine meetings have been held, at which fourteen papers were read and discussed, the attendances being fully up to the average.

The activities of the Society were very considerably increased by the Sections dealing with special branches of science. The Geological Section held six meetings during the year, and that of Public Health and Kindred Sciences four meetings; two other sections were formed at the beginning of the session, viz. Agriculture, which has held five meetings, and that of Industry, of which there have been six meetings. To the efforts of the Chairmen, Hon. Secretaries and Committees of these sections is due the success which has attended them.

A popular lecture entitled "The Chemistry of Nitrogen and its value for food stuffs and explosives" was delivered by Dr. Murphy, and one on "The debt of Agriculture to Science" by Professor Watt. The Society is indebted to

these gentlemen for the profitable and enjoyable information imparted at them.

The Society had, on the 13th March, the pleasure of entertaining Sir Ernest Shackleton on his return from the Antarctic, after the rescue of those members of his expedition who had been unavoidably left behind.

During the year I have, as your representative, attended several meetings of the Board of Visitors of the Observatory; one result of our recommendations has been that the Government Astronomer is to be provided with a suitable residence at the Observatory, it being evident that for some time to come funds will not be available for the erection of the new Observatory on the site selected for it at Wahroonga.

I am sure that in offering my thanks to the Hon. Secretaries, Mr. R. H. Cambage, L.S., F.L.S., and Mr. J. H. Maiden, I.S.O., F.R.S., as well as to the Hon. Treasurer, Dr. H. G. Chapman, for their constant and generous services in the interests of the Society, I am expressing your feelings as well as my own.

It was with great pleasure that we received the announcement that the "David Syme Prize for Scientific Research" had been awarded to Mr. C. Hedley, F.L.S., for his zoological work. This high distinction has only been awarded nine times, and it is a source of satisfaction to us all that five of the recipients are members of this Society.

On April 30th, 1916, there were 299 members on the roll, of whom 28 were Honorary Members; during the year we have lost by death and resignations 10, including one Honorary member, and four names have been removed from the rolls, 31 new members have been elected, the membership now being 316, including 27 Honorary Members. The losses by death are :—

Colonel Dr. JAMES FROUDE FLASHMAN, who was born at Braidwood in 1870, and educated at the Sydney High School and Sydney University. For some years he held the office of Senior Medical Officer and Pathologist, first at Parramatta and afterwards at Callan Park Hospital for the Insane. He then became Pathologist and Lecturer at the University, where he was much esteemed by all with whom he came in contact, especially the young students, for whom he always had much sympathy. All through his life he was much attached to military matters, and was the leader of the University Scout movement. Of late years, after resigning his position at Callan Park, he entered upon private practice, and succeeded in securing a large practice, and was particularly successful in treating many complicated diseases. On the outbreak of war he offered his services as medical officer and was immediately sent to England, and placed in charge of No. 3 Hospital at Wandsworth, chiefly used for Australian wounded. Afterwards he was transferred to France to take charge of the hospital at Boulogne, where he contracted pneumonia and died on 12th February, 1917. He was elected a member of the Society in 1900.

Mr. WALTER GEORGE PYE was born in England and came out to New Zealand when quite young; he graduated B.A. in 1893, M.A. in 1894, and B.Sc. in 1895 at the University of New Zealand, taking high honours both in languages and literature and science. On leaving the University he was for some time engaged in educational work in the secondary schools of the State and elsewhere, but subsequently entered the profession of journalism in which most of his life-work was done. He wrote the "Review" columns of the *Sydney Morning Herald* for many years, and endowed them with personality and distinction, the gift of epigram being peculiarly his own. He

died at the age of 46 years, on 12th March, 1917. He was elected a member in 1908.

Dr. Edward Pierson Ramsay, born at Dobroyde, Ashfield, in 1842, a son of Dr. David Ramsay one of the early settlers in Australia, was educated at St. Mark's School, Macquarie Fields, and afterwards at Darling Point, under the Rev. G. S. Macarthur. He followed in the footsteps of his father and showed great interest in natural history study. When Dr. Pittard was the Curator of the Australian Museum in Sydney, Dr. Ramsay travelled in New South Wales and Queensland in search of specimens suitable for the Museum, and subsequently in 1874 was appointed Curator, a post he filled with much success until 1895, when he was compelled to retire through ill-health. He was then appointed Consulting Ornithologist to the Museum, a position he held until his death. While natural history was the chief branch of his scientific research, he took a keen interest in the advancement of science generally. His early love for botany found expression in the Dobroyde new plant nursery, through which a large number of plants were first introduced to Australia. Bird and animal life also largely claimed his attention, and he worked in collaboration with the late Sir Richard Owen (England) on the extinct animals of Australia, among which were discovered the giant kangaroo and marsupial lion. On another occasion Dr. Ramsay was requested by John Gould to guard his Australian interests in his famous folio work "Birds of Australia." In the work of furthering the advancement of science in Australia Dr. Ramsay was, together with Sir William Macleay, one of the founders of the Linnean Society. He was elected a member of this Society in 1865, and was also a Fellow of the Geological Society of England, a Fellow of the Royal Geographical Society, a Corresponding Member of the Zoological Society of England, and a

member of the Royal Irish Academy. He died on 16th December 1916.

Rev. WILLIAM SCOTT, born at Hartland, North Devon, in 1825, took his B.A. degree at Cambridge University in 1848, taking honours as Third Wrangler at the same time as the late Isaac Todhunter, the well known mathematician. He arrived in the State in 1856, having been selected by the Astronomer Royal for the position of Government Astronomer. Early in 1862, Mr. Scott, for health reasons, sent in his resignation as Astronomer, and shortly after took over the old Cook's River collegiate school from the Rev. W. H. Savigny, and in 1865 he was appointed Warden of St. Paul's College within the Sydney University. He was Hon. Secretary of the Royal Society of New South Wales from 1867 to 1874, and Treasurer for several years. In 1878 Mr. Scott resigned the Wardenship of St. Paul's and entered into parish work in the Goulburn diocese, where he successively held the incumbencies of Gunning, Bungendore, and Queanbeyan, and was appointed a Canon of St. Saviour's Cathedral, and examining Chaplain to the Bishop. After resigning his parochial duties, Mr. Scott revisited England with his wife. He died on 29th March, 1917, at the age of ninety-one years. He was elected a member of the Society in 1856, being before his death the oldest member.

Mr. JOHN TEBBUTT was born in Windsor, New South Wales, on May 25th, 1834, and educated in private schools, his early inclinations being towards mechanical pursuits. His mind was first directed towards the science of astronomy when he was nineteen years old, but it was not until eleven years later that he became possessed of instruments with which he could practically test his knowledge, which included a fair grounding in higher mathematics and the theory of astronomical instruments. Mr. Tebbutt may be said to have been the first great Australian born

astronomer; he was a native of the soil and entirely self taught. Outside his own personal researches and studies, the only experience he ever gained in any other observatory than his own, was during three days he once spent in the Sydney Observatory. Commencing as a mechanic, he evidenced genius as a lad in the making of models. His first taste for astronomy he used to say was acquired from reading an article in the *Illustrated London News*. Henceforth he lived in an atmosphere of moving planets. The science of astronomy became his ruling passion; all else to him went by the board, and he had perpetually in his mind, while pursuing his study of the starry heavens, a working model of the universe, whose mysteries it was the purpose of his life to unfathom. Towards the close of 1863 he managed to erect on his father's property a small observatory built of wood, which was entirely the work of his own hands. His first installation was a small transit instrument and a $3\frac{1}{4}$ inch refractor, which he mounted himself as an equatorial. From these small beginnings Mr. Tebbutt's zeal led him on until he possessed two substantial brick observatories, which accommodated one of Cook and Sons' 3 inch transit instruments, a $4\frac{1}{2}$ inch equatorial by the same makers, and an 8 inch equatorial refractor by Grubb. In 1862 Mr. Tebbutt was elected a member of our Society. He was one of the few surviving members of the Society then known as the Philosophical Society of New South Wales. The first Government Astronomer for New South Wales (Rev. W. Scott) so far recognised Mr. Tebbutt's abilities in 1863 as to recommend him as his successor, but he declined the office. Six years later his work was considered of such importance that his private observatory was placed in the list of principal observatories in the British Nautical Almanac. It was subsequently recognised in a similar way in the national ephemerides of the United States, France, Germany, Brazil,

and Mexico. For a paper written in 1867 for the Paris Exhibition, on "The State and Progress of Astronomy in New South Wales," he was awarded a commemorative silver medal. In 1873 Mr. Tebbutt was elected a Fellow of the Royal Astronomical Society, though his contributions had been published by the Society for eleven years preceding that date. He was the recognised discoverer of two of the most remarkable comets of the last century, the 1861 comet having been observed by him six weeks before it was discovered in Europe; the other was the great comet of 1881. His comet work finds a place in several well known astronomical monographs. Concurrently, Mr. Tebbutt conducted extensive meteorological observations. His work in this connection from 1863 to 1896 has been published, but at the close of 1897 Mr. Tebbutt discontinued these observations, leaving himself free in his declining years to continue his purely astronomical work. In 1895 Mr. Tebbutt was elected the first President of the New South Wales branch of the British Astronomical Association. He died on the 29th November, 1916, in his eighty-third year.

Honorary Member.

Professor Daniel Oliver was born at Newcastle-upon-Tyne, on February 6th, 1830, and was educated partly in private schools. Attached from an early age to botanical study, and a youthful member of a local scientific society, we find him in 1847 contributing to the *Phytologist* a list of rare plants from different geological formations, and in 1850 adding a new genus to the flora of the United Kingdom. In 1851 he became a fellow of the Edinburgh Botanical Society, and in 1853 of the Linnean Society. His reputation as a keen and critical worker, gained in the north of England, was already such as to prompt Sir William Hooker to invite him to assist his son in the heavy task of arrang-

ing and distributing the botanical collections accumulated by the East India Company and to induce him in 1858 to become an assistant in the Herbarium at Kew. On settling there, Oliver instituted in 1859 a course of lectures on Botany, which he continued to conduct until 1874, for the benefit of the young gardeners. He proved so excellent a teacher that in 1861 he was appointed to the Botanical Chair which had been occupied by Lindley at University College, London, which he retained until 1888. He held for twenty-six years the Keepership at Kew until he retired from public service in 1890. After his retirement he succeeded Sir Joseph Hooker as editor, on behalf of the Bentham Trustees, of the *Icones Plantarum.* This duty he fulfilled for five years, so that his connection with the institution where he worked so long, and for which he did so much, was not finally severed until 1895. In 1884 the Royal Society, of which he had been a Fellow since 1863, recommended him as the recipient of a Royal medal. In 1891 the University of Aberdeen conferred on him the degree of LL.D. In 1893 the Linnean Society awarded him its gold medal, and a number of friends arranged for the painting of his portrait by Mr. J. Wilson Foster for presentation to the Herbarium at Kew. On his attaining his eightieth birthday in 1910, old colleagues united with the existing Herbarium staff in offering him an address of congratulation. He was elected an Honorary Member of our Society in 1905, and died on 21st December, 1916, in his eighty-seventh year.

I have also to record the death of W. H. WEBB, for thirty-six years a faithful officer of the Society; he was Assistant Secretary for many years, and when, in consequence of failing health, he had to relinquish that office, he was appointed Assistant Librarian, and continued as such until the date of his death, 29th August, 1916.

The Geo-physical Observations at Burrinjuck reservoir, which were described in the paper read by Acting Professor Cotton in 1915, have been continued, but owing to pressure of University business, he has not been able to work up the results. However, sufficient observations have been made to render it quite certain that movement of the earth's crust has been taking place at the site of each of the pendulums; the records also show earthquakes and earth tides.

The importance of molybdenum in the manufacture of steel has been greatly increased as a result of the war. This State is one of the principal sources of the supply of molybdenite from which it is prepared, and recently the Mines Department has issued a very important work on the subject, prepared by Mr. E. C. Andrews, which deals very exhaustively with the occurrence and working of the deposits in this State.

The Advisory Council of Science and Industry, established about a year ago, has initiated many investigations on subjects of considerable importance, the problems now being dealt with, and for the solution of which special committees have been appointed, are :—1. Ferro alloys; 2. Manufacture of chemicals; 3. Alunite; 4. Posidonia fibre; 5. The laws governing the mode of occurrence of gold in quartz; 6. The tick pest in cattle; 7. The nodule disease in cattle; 8. Yeasts and bread making; 9. The standardization of physical apparatus; 10. The cultivation of cotton and the problem of a mechanical cotton picker; 11. The prickly pear; 12. The brown coal of Victoria; 13. The sheep fly pest; 14. Wheat selection and breeding; 15. Indigenous grasses and salt bushes; 16. The standard for alcoholometry; 17. Forestry and timber industries.

Many members of the Society and other scientists of the State are actively engaged in these investigations, and

that on yeasts, now being carried out at the Technical College by Dr. Chapman, will, it is anticipated, effect considerable alterations in the present methods of bread making, his endeavour being to produce a yeast that will ferment earlier, and thus enable the dough used for bread making to ripen more rapidly.

The Advisory Committee is collecting information and establishing relations with other public and professional bodies interested in scientific research and industries, and I look forward to great advantages resulting from this attempt to co-ordinate research throughout the Commonwealth.

During the past year the question of the organization of chemists has come into prominence. At the suggestion of Professor Orme Masson, chemists have met together in the different States, and have elected committees to prepare a constitution for an Australian Chemical Institute. Representatives from the various States met together in Sydney in January 1917, and drew up a constitution, which has been accepted, with some alterations, by the committees in all the States. It is hoped that the formation of this professional organization will lead to a better recognition of the value of chemical work. A Federal Institute should command the confidence of those requiring chemical assistance in mining, manufacture, and primary production.

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I had a difficulty in finding a suitable subject for my presidential address that would be of interest to members, as the scope of the work carried out by engineers in private practice in this State is not such as to enable me to describe any great system of works such as my predecessors have been able to do. As it was twenty-five years from the date of my election as a member until I had the honour of being elected President, it occurred to me that a review of some

of the developments of engineering in the State for that period might prove interesting. The Society's Proceedings have been enriched with many valuable addresses and papers on various aspects of engineering, and I must ask your forgiveness if I repeat any of the information contained in them.

Railways.

The largest expenditure of money on engineering works has naturally been by the Government, nearly all works of public utility having been carried out by them, the railways standing first in importance and expenditure. The length of line in miles in operation was for the two periods as follows:—

	1891	1916
Five lines ...	...	1
Four lines ...	...	33
Three lines...	...	8
Double line	124	492
Single line ...	2,058	3,654
Total ...	2,182	4,188

and the capital expended for construction and equipment, which in 1891 was £31,768,617, had risen in 1916 to £68,825,592, the costs per mile being £14,559 and £16,434.

Of the 2006 miles of new railway constructed within the period under review, about 1,500 miles have been in the area devoted to the cultivation of wheat, and are what may be termed pioneer lines, that is of light construction without ballast, 200 miles, viz: that comprising the completed sections of the North Coast Railway, which will when completed form the express route to Brisbane, have been built to correspond with the other main lines carrying heavy traffic. The engineering works on this line have been heavy, the following rivers having to be spanned by heavy steel bridges:—the Hunter, Paterson, Williams,

Manning, Hastings, Wilson, Macleay, Nambucca, and Bellinger (south arm and north arm), besides a number of smaller streams.

A new departure in the construction of the piers for these bridges was introduced and successfully used by Mr. W. Hutchinson, M. Inst. C.E., the Chief Engineer for Railway Construction; formerly it has been the practice to use cast iron cylinders for sinking in the river beds to carry the superstructure, but he adopted concrete without reinforcement, except on the curb or cutting edge. Many of the piers were sunk under air pressure, but even in those cases concrete was the only material composing the cylinders; the saving in cost that resulted from this method over that hitherto adopted was considerable.

Not only have the large bridges on the North Coast line been in excess of what is found on other lines in the State, but the number of tunnels, mostly through solid rock, have also been proportionately more numerous than on any portion of the lines, except that from Hornsby to the Hawkesbury River, the ruling grade is 1 in 80 and the sharpest curves 15 chains, the whole being laid with steel rails weighing 80 lbs. per yard.

With this exception, the construction of the various lines has presented no engineering difficulties.

The new Sydney Terminal Station, opened for use in 1906, soon proved too small for the growing requirements of the city, and it is to be hoped that the City Railway will be an accomplished fact as soon as conditions become such that it can be constructed at reasonable cost.

Although the extensions of the railways have not, with the exception stated, been difficult, yet the alterations that have been made to existing lines in consequence of increase in traffic, or with a view to economy in working,

have involved very considerable difficulties to carry them on without interference with the daily traffic.

During the Eddy regime, which commenced in 1888, the work of duplications and reducing grades and easing sharp curves was taken in hand. In 1891 there were 124 miles of double line, which length has in 1916 been extended to 534. The carrying capacity of double to single line being as 4 to 1, some idea is obtained of the extra amount of traffic which can be handled.

When the work of grade improvements commenced, there were 25 miles of 1 in 30 and 1 in 33, and 185 miles of 1 in 40 and 1 in 42 gradients, while at the present time only 13½ miles of 1 in 30 and 1 in 33, and 136 miles of 1 in 40 and 1 in 42 remain. The balance have been replaced by 1 in 75 and 1 in 80 grades; the alterations for the mileage treated, represent an increase in the capacity of 36,000,000 ton-miles per annum due to grade reduction alone, while the improvements made in the haulage power of locomotives have also greatly added to the capacity of the system.

Among the most important of the grade improvements is the cutting out of the two Zig Zags on the Western line; work at the small Zig Zag between Emu Plains and Glenbrook was commenced in 1891 and completed in 1893 by a single line deviation.

The Gas Works at Eveleigh for the supply of oil gas were constructed in 1892, and with necessary additions has provided requirements for train lighting up to the present time.

A deviation between Muswellbrook and Singleton to effect a grade improvement was carried out in 1893, and the same year saw the completion of the quadruplication of the Main Suburban line between Sydney and Flemington. In 1895, grades on the Northern line were reduced and also on the Western line. In the following year further grade improve-

ments were carried out on the Southern and Western lines. The duplication of the line between Blackheath and Mount Victoria was completed in 1898, and that between Glenbrook and Katoomba, with important curve improvements, involving practically the remodelling of the whole of the station buildings in that section in 1902.

On the Western line, from Sydney to Mount Victoria, there remained a gap of a single line between Penrith and Glenbrook, the crossing of the Nepean River at Emu Plains being over a single line bridge. To provide for the future linking up of the double roads, a new steel truss bridge was erected, comprising four spans of 200 feet, and one of 125 feet. The superstructure, weighing 1,300 tons, is supported on brick piers and abutments, a feature in the erection being the absence of false work owing to flood risk. Erection was commenced at the Penrith end, and the girders built out over the piers on the cantilever principle, temporary links being provided to take up the tension between the ends of girders. This bridge and the duplication between Penrith and Emu Plains were opened in 1907.

The opening of the new Sydney Railway Station in 1906 necessitated the complete remodelling of the whole yard, and the cutting out of the old station building, and bringing into use the new, with its various requirements; the entire alteration of the signalling arrangements in the yard was a necessary consequence, the whole of the work being carried out so as to interfere as little as possible with the running traffic. At this time the coal business at Newcastle required facilities to meet the increasing traffic, sorting sidings were provided at Port Waratah to accommodate 5,000 waggons and an up-to-date Round House, with coaling and watering arrangements, sufficient to deal with forty engines was provided. To expedite the shipping of coal a McMyler hoist was erected at the top end of the

Dyke Wharf, and this, like all innovations, came in for a large amount of adverse criticism. The prejudice has, however, now almost disappeared, and the hoist has proved itself equal to at least two cranes, when loading under ordinary conditions. Records show that with large hatches a rate of from 500 to 550 tons an hour can be maintained until trimming commences.

A coal handling plant at Pyrmont Jetty was provided in 1908 to deal with bunker coal, with a capacity of 200 tons per hour. In the same year work was commenced at Flemington in connection with the lines and platforms required for the new Abattoirs now in course of completion, and the ever increasing traffic called for further marshalling facilities between Auburn and Clyde. The six and a half miles of sidings provided at Clyde in 1892 became inadequate, and separate sidings were required to deal with down traffic, leaving up traffic to be handled at Clyde.

The duplication of the North Coast line between Hornsby and the Hawkesbury was completed in 1909, and between Lindfield and Hornsby in 1910, that between St. Leonards and Lindfield having been opened in 1901, including the remodelling of all intermediate station yards, and increased accommodation at Hornsby. Beyond Hawkesbury, the duplication towards Newcastle was extended to Wondabyne in 1909, and linked up to Teralba in 1912, completing the double line between Sydney and Newcastle. By this time traffic throughout the lines had increased to such an extent that long single line sections had to be divided, and crossing loops provided at suitable sites. In all forty-seven loops were laid in, and when designing them, care was taken to ensure their linking in with the future duplication.

The Otford Tunnel on the South Coast line was for some years an awkward spot for enginemen and uncomfortable for passengers. This tunnel is nearly one mile long on a

1 in 40 grade falling from Sydney, and remained an obstruction to the South Coast traffic until recent years. With the application of mechanical ventilation, consisting of a sirocco fan developing 170 H.P., and supplying air at the rate of 250,000 cubic feet per minute, a beneficial change has been effected, not only to the travelling public and the enginemen, but owing to the rails being kept dry by the air in motion, there is a noticeable increase in the load hauled. The work of cutting out the Otford Tunnel by a deviation between Otford Station and Coal Cliff is now well in hand, and when complete, great relief will be experienced by all concerned.

The main difficulty on the Main Western line was the descent into the Lithgow Valley which was negotiated by the great Zig Zag, a fine work in its day, but not suitable for the heavy traffic of later years. It became apparent that some better means must be provided, and many trial surveys were made, the result being that a scheme was prepared by the Engineer-in-Chief, and approved by the Commissioners.

This work, which was commenced in 1908, and opened for traffic on 16th October, 1910, calls for special reference, not only because there were eleven tunnels to be driven, but also, owing to the great urgency for completion, special methods had to be adopted in dealing with the supply of material, and providing arrangements such as would allow of as many tunnels as possible being dealt with simultaneously. A difficulty with regard to the provision of the material for tunnel lining, platelaying etc., presented itself owing to the fact that the No. 1 and No. 11 tunnels—the longest—were at almost the extremities of the work. At the Sydney end, connection was possible with the main line at Clarence, and a suitable depôt was formed there to deal with the material required at No. 1 tunnel end. A con-

nection direct with the main line at the western end was not practicable, but the difficulty was met by the provision of a funicular railway connecting a material siding alongside the main line and a point on the deviation between Nos. 10 and 11 tunnels. This enabled a supply of material to the tunnels between Nos. 1 and 11, and was effective in greatly reducing the time occupied in the work. The tunnels were driven through hard sandstone formation, and timbering was only necessary in three places. Excavation was expedited and cheapened by the installation of an electrical power station, which provided current necessary to drive the air compressors, lighting for tunnels, and fans for ventilation. The amount of material excavated was 830,000 cubic yards, while 14,055 cubic yards of concrete, and 7,500,000 bricks, were used in the construction of the tunnels and culverts. The new grade was 1 in 90 as against 1 in 42 in the middle road of Zig Zag. In 1910, on completion of this work and the duplication of line between Mount Victoria and Newnes Junction, the duplication of the remaining section of single line between Emu Plains and Glenbrook was commenced, and was opened for traffic in 1913. The deviation begins about half a mile west of Emu Plains and ends at Blaxland, and includes one tunnel and a large viaduct at Lapstone Hill. There were 1,463,000 cubic yards of excavation, and 12,000 cubic yards of concrete, and 6,000,000 bricks were used in the work. Near Glenbrook Creek and running parallel with it for about one mile, the line is cut out of the face of the cliff, which is 700 feet above the creek bed; the work was of a most dangerous nature, and unfortunately it was the scene of several fatalities. In engineering difficulties the work presented features more than equalling the great Zig Zag problem. With its opening on the 28th September, 1913, the last piece of single track between Granville and Eskbank disappeared. On this work steam navvies were

first employed, the large bank between Emu Plains and Lapstone Junction being constructed at the low cost of 1/8½ per cubic yard.

In 1912 the new double line between Flemington and Glebe Island, designed to relieve the main suburban lines of goods traffic, was commenced, and was completed on 29th May, 1916. The goods line leaves the suburban lines on the up side at Lidcombe, junctions with the Abattoirs' railway and the Northern line connections near Flemington, passes beneath the main lines, and connects with the Bankstown Railway near Campsie Station, runs parallel with that line to a point between Hurlstone Park and Wardell Road, where it branches off to the north, and passes under the main suburban line at the Lewisham Viaduct, and thence through Leichhardt to Glebe Island. At Wardell Road connections are provided, and the goods lines extended to junction with the South Coast line near Tempe Station. Between Flemington and Campsie a large area of land has been taken and extensive marshalling yards provided, also provision for housing all goods locomotives, with the necessary coaling and watering arrangements. On this work steam navvies have been largely used, 1,250,000 cubic yards of material, mostly hard shale and rock, having been excavated and disposed of for 1/9d per cubic yard.

On the Southern line duplication work has been pushed ahead, that between Marulan and Cullerin being commenced on each side of Goulburn in 1913; the crossings of the Wollondilly River, Boxer's Creek, and Mulwaree Ponds Viaduct consist of fifty feet semi-arches in brickwork. That portion between Bowral and Harden is now complete, and the work of cutting out the remaining length of single line between Picton and Bowral is well in hand.

On the South Coast, duplication work has also been in hand. The section—Waterfall to Otford—has been opened

since 30th May, 1915. This work consisted of a deviation, commencing at the South end of Waterfall tunnel, which is now cut out, and running on the up side of the old line, crosses it at three places, and finally junctions at Lilyvale, from whence ordinary duplication extends to Otford. On the old line four tunnels were cut out, and three new tunnels were built on the deviation, 1 in 80 grades replacing 1 in 40. Duplication work has also been completed between Scarborough and Bulli Junction, the gap between Otford and Scarborough being now well in hand. In connection with this section a large locomotive depôt has been completed at Thirroul, the old depôt at Waterfall being abandoned.

A length of $7\frac{1}{2}$ miles of third road has been laid in for goods traffic on the suburban lines, as well as a fifth road from Newtown to Petersham.

The increase of traffic which necessitated the main line improvements already referred to, also required extended and additional facilities in other branches of the Department. To expedite the handling of engines, up-to-date housing and coaling arrangements have been completed at Port Waratah, Enfield, Thirroul, Harden, and Werris Creek, and a large depôt to deal with eighty-four engines is well in hand at South Goulburn.

With the call for increased locomotive accommodation came the accompanying demand for ample water supplies, capable of meeting, during the time of drought, the maximum consumption of a busy season. These works alone are of great magnitude, and with the dams, reservoirs, pumping plant, mains, and yard details, including supply tanks, cranes, etc., involve a large expenditure. Also the locomotive workshops have been extended, and additional erecting shops and a large up-to-date foundry at Eveleigh completed.

The faster the trains are moving with their loads to their terminal stations, the greater the necessity for ample and efficient means of handling the freight, and freeing the rolling stock for the return journey. Extensive additions have been provided for the handling of wheat, and the facilities now in operation have so far been able to cope with the demands made upon them. With a view to the future, a large produce shed has been completed at Alexandria 1,000 feet by 200 feet, where most of the Sydney produce business is transacted. A large double tier goods shed is in course of erection at Darling Harbour, and when complete, with electric cranes and lighting, will be of great assistance in the handling of freight.

The progress in connection with interlocking and signalling on the New South Wales Railways during the last twenty-five years has taken place along three definite lines. Prior to 1891, considerable progress had been made in the interlocking of stations on the system, but a great deal still remained to be done. The earliest interlocking carried out in New South Wales was in the year 1883, and by the year 1891, 250 places had been interlocked. By the end of the year 1916, the total number of interlocked places on the New South Wales railways amounted to 969. A more accurate way of expressing the progress of interlocking is in terms of "Points and Crossings" rather than "Places," and on this basis, at the end of the year 1916, there were 82·4% of the points and crossings throughout the system, on lines worked over by passenger trains, interlocked, leaving only 17·6% still unlocked. The installation of interlocking at the remaining places is being pushed forward as rapidly as possible, having regard to the funds available, and it is hoped very shortly greatly to decrease the number of places still to be dealt with.

In the year 1891, a large portion of the interlocking gear and fittings required were imported from England,

but since then it has become the practice to manufacture most of these within the State in the Departmental Workshops, and, so far as ordinary interlocking gear is concerned, the Department may now be said to be quite independent of imported materials.

The second line of progress in regard to this matter has taken place in respect of power interlocking. The first installation to be brought into use was an electro-pneumatic power plant in Sydney yard in 1910. This comprised two signal boxes, containing 59 and 203 levers respectively; since that time progress has been very rapid.

Additional electro-pneumatic installations have been brought into use in Sydney yard and at Illawarra Junction, and a large electric installation has been brought into use at Flemington, in which no less than seven junctions are operated from one signal box. A further plant of all electric interlocking is now in progress of installation near Sydenham, and from this four separate junctions will be worked. The total number of power plants in operation in the State is five, with a total of 600 levers.

The third line of development has been in connection with automatic signalling, and this has taken place not only in the Sydney suburban area, but also on country sections. At present the whole of the suburban line, from Sydney to Sydenham, Belmore and Homebush, and the Milson's Point line as far as Bay Road, are signalled automatically. Numerous long sections in the country have been divided by means of automatic signals, thereby giving increased traffic provisions without the equivalent of additional staff.

The installation of automatic signalling is being rapidly extended, and there is no doubt that there is a great future for this form of signalling on the railways of this State.

Locomotives.

The additional length of railways in use would naturally entail an increase in locomotive power, and in Tables I and II, I have given particulars of the locomotives in use in 1891 and 1916, which show that in 1891 there were in use

Table I.—*Particulars of Engines showing the number in Classes, Tractive Power and Weight, on 15th September, 1891.*

Class.	No. in Class.	Description.	Tractive Power Each.	Total Tractive Power.	Weight Each.	
		REGULAR STOCK.	lbs.	lbs.	tons	cwt.
C	68	Passenger Tender engines	11,393	774,724	47	4
D 255	6	,, ,, ,,	11,528	69,168	48	1
D 261	41	,, ,, ,,	12,924	529,884	51	14
G	13	,, ,, ,,	10,357	134,641	40	9
H	12	,, ,, ,,	14,679	176,148	56	0
L 304	10	,, ,, ,,	15,467	154,670	53	2
L 436	10	,, ,, ,,	15,467	154,670	58	7
O	12	,, ,, ,,	20,110	241,320	64	17
P	50	,, ,, ,,	22,187	1,109,350	65	13
S	2	,, ,, ,,	9,796	19,592	40	9
F	18	Passenger Tank engines	13,087	235,566	31	19
M	15	,, ,, ,,	14,782	221,730	44	10
N	8	,, ,, ,,	5,633	45,064	21	16
Q	6	,, ,, ,,	11,374	68,244	32	15
R	6	,, ,, ,,	11,550	69,300	28	1
A	76	Goods Tender engines ...	16,335	1,241,460	44	6
B	95	,, ,, ,, ..	19,656	1,867,320	53	12
J 131	11	,, ,, ,, ...	18,808	206,888	55	0
J 483	20	,, ,, ,, ...	26,979	539,580	71	9
K	10	,, ,, ,, ...	20,216	202,160	47	19
E	12	Goods Tank engines ...	19,440	233,280	45	5
I	20	Goods Saddle Tank engines	19,656	393,120	51	7
	521	*Total Regular Stock* ...		8,687,879		
		DUPLICATE STOCK.				
Z10	1	Passenger Tender engines	10,352	10,352	40	13
Z14	3	,, ,, ,,	7,006	21,042	33	19
Z60	6	,, ,, ,,	16,484	98,904	46	13
Z36	7	Pass. and Goods Tender eng.	9,053	63,371	37	4
Z29	2	Passenger Tank engines ...	5,516	11,032	21	1
Z127	5	,, ,, ,,	6,291	31,455	22	16
					In steam	
Z17	22	Goods Tender engines ...	16,076	353,672	38	1
Z23N	3	,, ,, ,, ...	16,224	48,672	39	16
Z48	11	,, ,, ,, ...	19,423	213,653	45	5
	60	*Total Duplicate Stock* ...		852,153		

and duplicate 581 locomotives having a total tractive power of 9,540,032 lbs., the heaviest passenger and goods engines weighing about 66 tons and 71 tons respectively, whereas in 1916 there were 1,236 locomotives, having a total tractive power of 28,767,708 lbs., the weight of the heaviest passenger engine having risen to 92 tons, and the goods engines to 85 tons. This great increase in power, three times, and the reduction of grades, duplication of lines and other improvements enable the traffic, great as it

Table II.—*Statement of Locomotives and their Tractive Power on the 31st December, 1916.*

Class.	No. in Class.	Description.	Tractive Power Each	Total Tractive Power.	Weight.	
		Regular Stock.	lbs.	lbs.	tons	cwt.
D255	6	Passenger Tender engine	12,352	74,112	48	1
D261	41	,, ,, ,,	12,924	529,884	51	14
C	48	,, ,, ,,	13,096	628,608	47	4
CG	13	,, ,, ,,	12,442	161,746	40	9
H	12	,, ,, ,,	14,679	176,148	56	0
L304	10	,, ,, ,,	15,467	154,670	53	2
L436	10	,, ,, ,,	15,467	154,670	58	7
P	185	,, ,, ,,	22,187	4,104,595	65	13‖
					70	0§
P*	6	,, ,, ,,	23,187	139,122	72	0
O	12	,, ,, ,,	20,110	241,320	54	17
N	5	,, ,, ,,	23,929	119,645	80	7
NN	25	,, ,, ,,	25,943	648,575	91	18
M	15	Passenger Tank engine	15,767	236,505	56	15
CC	18	,, ,, ,,	14,032	252,276	41	8
S	144	,, ,, ,,	19,116	2,752,704	57	14
R	6	,, ,, ,,	11,550	69,300	28	1
J483	20	Goods Tender engines ...	26,979	535,580	71	9
J131	8	,, ,, ,, ...	20,375	163,000	55	0
T	205	,, ,, ,, ...	28,777	5,899,285	79	1
T*	75	,, ,, ,, ...	29,777	2,233,275	81	6
TF*	105‡	,, ,, ,, ...	33,256	3,491,880	85	3
TF†	60	,, ,, ,, ...	32,256	1,935,360	82	10
B	95	,, ,, ,, ...	19,656	1,867,320	53	12
A	12	,, ,, ,, ...	18,144	217,728	42	6
A	47	,, ,, ,, ...	19,440	913,680	44	16
I	20	Goods Tank engines ...	21,060	421,200	51	7
E	33	,, ,, ,, ..	19,440	641,520	61	9
	1236			28,767,708		

* With Schmidt superheater. † Without superheater. ‡ Includes one fitted with Robinson superheater. ‖ "P" class Six-wheeled tenders. § Eight-wheeled tenders.

now is, to be dealt with in a much more satisfactory manner than formerly, and the many improvements introduced by the present and former Chief Mechanical Engineers in design, have brought the locomotives of this State to a degree of perfection that can only be fully realised when one of the express engines of 1891, good as it was and is, is seen beside the new NN engines built at the Commissioners' Workshops.

Tramways.

In 1891 there was a total length of 42½ miles of street tramways in use, made up of the following sections:—

City and Suburban ...	33½	miles,	steam traction.
North Sydney ...	1½	,,	cable ,,
Newcastle	7½	,,	steam ,,

the cost of construction and equipment being £857,455, £74,343 and £72,414 respectively, making a total of £1,004,212.

Until the construction of the Ocean Street Cable Tramway in 1894, only small additions had been made to the mileage, and it was not until after electricity was first used as the motive power at the end of 1899, on the line from Circular Quay to Pyrmont, that the large expansion of the tramway system commenced, there being now 221 miles open for traffic in and about Sydney, Newcastle, and Broken Hill. Table III shows how this is distributed, and

Table III.—*Tramways in 1916.*

	Miles.	Chains.	Cost.
City and Suburban, Electric...	111	17	£6,332,434
North Sydney, Electric	19	31	659,501
Ashfield to Mortlake, Electric	8	38	200,816
Arncliffe to Bexley, Steam	2	50	21,752
Kogarah to Sans Souci, Steam	5	45	27,814
Parramatta to Castle Hill, Steam	6	55	38,446
Manly to Spit ... / Manly to Narrabeen } Electric	10	58	320,459
Sutherland to Cronulla, Steam	7	32	49,696
Rockdale to Brighton, Steam	1	20	13,491
Newcastle and Suburban, Steam	32	69	374,789
East to West Maitland, Steam	4	47	38,941
Broken Hill, Steam	10	4	88,284

the capital, cost of construction and equipment being £8,166,423; this has increased to eight times what it was twenty-five years previously, although the length of line operated has only increased about five times.

After the opening of the electric line to Pyrmont, great progress was made in the reconstruction and electrification of the existing steam lines, and extensions were made at a rapid rate for many years, until now Sydney has a tramway system stretching its lines out into far distant suburbs, the only drawback apparently being that it cannot at times carry all who desire to travel by it without overcrowding; that is, however, a failing of many suburban transport systems.

The power house in which the electric current was generated for the first tramway at Pyrmont, contained at the commencement four 850 kilowatt 660 volt direct current generators driven by compound engines. The conversion of the lines from steam to electric soon made additional power necessary, and in 1902 three 1500 kw. alternating current generators, driven by compound vertical engines were erected, in 1905 the first turbine driven alternator was put to work; it was of comparatively small capacity, 1500 kw. and was soon followed by others. The plant now comprises the following turbine driven alternators producing current at 6600 volts and 25 cycles per second: one 1500, four 5000, one 7000, and one 7500 kw., a total rated capacity of 36000 kw., but capable, when required, of temporarily carrying an overload up to 50000 kw.

Three of the direct current generators first installed have been removed, one being retained for night work and lighting, the three vertical engines and the generators installed in 1902 have also been disposed of.

At White Bay a new power house has been built to supplement the one at Prymont; it contains three turbine

driven alternators with a rated capacity of 21,500 kw., but which can generate during an emergency about 30,000 kw.

At both stations the equipment of boilers and their appurtenances, switch gear, indicators, meters, and other electrical appliances are of the most modern type ensuring safety and economy in working.

The current generated at these two stations is converted into direct current by rotatory convertors at sixteen sub-stations, and from them distributed to the overhead trolly wires. When the system was first introduced large storage batteries were provided, but the necessity for these has disappeared, for it has been found cheaper to lay duplicate mains and provide more convertors to obviate the risk of interference with traffic in consequence of a breakdown of a machine or cable.

The current for operating the lines on the northern side of the harbour, is conveyed by cables laid in a tunnel under the harbour, starting at Long Nose Point. The construction of this involved some engineering difficulties, for although it is 135 feet below the bottom of the harbour at that point, silt and sand broke in through an unsuspected fissure, filling the tunnel. It was subsequently cleaned out and the fissure closed up.

In 1902 the "Thermit" welding of the tram-rails was introduced; prior to that time, in order to obtain the proper electrical and mechanical connection between the rails, extra long fish plates, carefully planed and fitted to the rail were used; this, after being in use for fourteen years, has now been dispensed with in favour of electric welding, which is both cheaper and more efficient. Instead of the rails being welded at the ends they are carefully butted end to end, and then fish plates are welded to the sides of the rails, forming a mechanically good joint and an efficient conductor for the return current.

A source of trouble and expense to the Commissioners, and annoyance to the public, has been the rapid wear of the crossings, especially at such busy centres as the intersection of King Street with Elizabeth, Castlereagh and George Streets. Manganese steel crossings of the very best materials were used at these places, but that did not obviate the wear and bumping which resulted from it, and the delay to traffic which when a large crossing is being replaced is unavoidable. Now, however, by means of electric welding, it is possible to deposit a surface of tool steel on the face of the crossing as soon as it shows any signs of wear, and the crossing is thus made practically everlasting.

Privately Owned Railways.

There are in the State 143½ miles of privately owned railways, the most important of those recently constructed being the 33 miles of line connecting the works of the Commonwealth Oil Corporation with the Government Railway at Newnes. This line is interesting owing to the heavy grades and the type of locomotives used on it. An interesting description of the difficulties overcome was given by our past President, Mr. H. Deane, M. Inst. C.E., in his Presidential address in 1908.

Roads and Bridges.

On the passage of the Act conferring Local Government on the country districts in 1906, the control of the roads and bridges was transferred to local bodies, national works still being retained by the Government, which also subsidised the Shires to a considerable amount. So far there appears to have been no material improvement in the main roads, but the necessity for improvement is being forced on the public in consequence of the great increase in fast motor traffic, and although the outlay will be considerable, the gain will be more than commensurate.

Few country bridges of any length, or possessing any notable engineering features, have been constructed since 1891; the following five are the principal ones:—

Kempsey Bridge over Macleay River. Built in 1900 at a cost of £22,345, consists of four timber trusses 153 feet each, and nine approach spans, with length overall of 925 feet, width of roadway 22 feet 6 inches.

Cobram Bridge over Murray River. Built in 1902 at a cost of £20,000, consists of two composite trusses 104 feet span with a steel lift span of 58 feet, and nine approach spans, having an overall length of 575 feet. The width of deck on lift span is 16 feet 6 inches, and 19 feet 9 inches on other spans with a 3 feet 6 inches footway.

Luskintyre Bridge over Hunter River near Lochinvar. Built in 1903, at a cost of £19,700, consists of two steel spans of 199 feet each, and 15 timber approach spans with an overall length of 916 feet, the width of roadway being 18 feet.

Richmond Bridge over Hawkesbury River. Built in 1905 at a cost of £20,225. Consists of thirteen concrete arches, 54 feet each, length overall of 722 feet, with a 20 feet roadway.

Wakool Bridge over Wakool River. Built in 1913 at a cost of £15,524, consists of one 104 feet composite truss, steel bascule span 66 feet, steel track span 68 feet and seven timber approach spans having an overall length of 452 feet. The width of deck on the steel spans is 14 feet, and on the other spans 18 feet.

The most important bridges built within the period are Pyrmont and Glebe Island swings spans, they are constructed throughout of steel and swing on central piers, all operations being performed electrically. They were built by the Public Works Department under the direction of

Mr. P. Allan, M. Inst. C.E. They are similar in design, the leading dimensions being:—

	Pyrmont.	Glebe Island.
Length over all	...223 ft. ...	195 ft. 4 in.
Width of roadway ...	... 40 ft. ...	40 ft.
Width of footpaths each	... 7 ft. ...	5 ft.
Width of clear waterways each,	80 ft. ...	60 ft.
Weight of swing ...	...798 tons ...	650 tons.

As it has been decided to fill in that portion of Darling Harbour above Bathurst Street with spoil from the excavations being made for the City Railway, Pyrmont Bridge will no doubt be removed, and the swing span utilised at some other site, and no doubt in time, as the requirements of the Port extend, Glebe Island bridge will have to be removed, as it limits the dimensions of vessels which can enter Blackwattle and Rozelle Bays, a tunnel from Pyrmont to Glebe Island taking its place.

Ports and Harbours.

Although Railways and Roads are required for the development of the greater portion of the State, yet along the seaboard water carriage will always be the cheapest. Much of the richest land of the State lies along the numerous rivers discharging into the Pacific, and as a consequence, large towns and villages have grown up whose only means of getting their produce to market is by water. In order that this may be done, it is essential that the rivers be kept open for navigation and the entrances made as safe as possible.

Owing to the frequency of floods, which bring down large quantities of silt, the mouths of the rivers become choked, and frequently changes in the position of the outlets occur. Another obstacle to safe navigation was the great difficulty caused by the shifting and dangerous state of the sand bars at the entrances, the only means by which

these drawbacks to trade could be overcome was by the construction of costly improvements, which would create sufficient scour to maintain a suitable depth of water on the bar, and also permanently fix the position of the entrance, leaving the silt to be dealt with by dredges.

Observations and soundings had been carried on for some time at the principal rivers, in order that proper remedial measures could be adopted, when a few years before the period under review, the Government obtained the services of Sir John Coode, M. Inst. C.E., who prepared improvement schemes for a number of the bar harbours. Various modifications have been introduced into his designs as more extensive knowledge became available, and although at none of the river entrances, with the exception of the Richmond and the Hunter, is the work actually completed, yet the benefit of the works carried out has been felt for some time.

Over £3,000,000 had been expended on these improvements up to the end of June 1916, exclusive of the large sums spent on Sydney and Newcastle Harbours.

Table IV shows the distribution of this expenditure, and the extent to which the depth of water has been increased, and in Table V are given some detail statistics of the rivers and their entrances.

At Port Kembla there has been provided a very effective coal loading apparatus, which, by means of a travelling belt, discharges coal tipped into a large hopper at the shore end of the jetty, into the holds of steamers moored to it; 600 tons of coal an hour have been loaded by it into ocean going steamers.

Newcastle was in 1891 a well equipped port, but the constantly increasing trade, and the greater draught of the ships using it, have made necessary many additions. The Northern Breakwater has been extended by 420 feet at a

Table IV.—*Expenditure on Ports along Coast of N. S. Wales, (omitting Port Jackson).*

Ports or Tributaries.	Expenditure to 30-6-1916, Exclusive of Dredging.	Cost per Annum. Mean over a Fourteen Year Period.	
		Dredging.	General Maintenance
	£	£	£
Tweed River	98,666	6,021	293
Byron Bay	38,054	65	277
Richmond River	490,617	10,135	904
Clarence River...	490,618	7,576	413
Woolgoolga	16,799	...	480
Coff's Harbour...	72,979	...	488
Bellinger River	70,410	3,117	27
Nambucca River	50,928	3,498	49
Macleay	100,440	4,257	322
Trial Bay	95,376	...	73
Hastings	29,659	1,979	105
Camden Haven	53 065	2,491	94
Manning	121,355	6,382	241
Cape Hawke	16,642	2,379	35
Newcastle	946,238	46,368	4,818
Lake Macquarie	93,634	804	50
Botany Bay and Cook's River	210,043	1,723	170
Wollongong	130,476	152	312
Port Kembla	552,786	38	1,205
Shell Harbour	10,277	...	4
Kiama	89,203	16	55
Shoalhaven	24,084	201	103
Crookhaven	25,246	1,171	48
Ulladulla	12,962	...	90
Bateman's Bay	18,792	596	154
Moruya	69,926	1,187	73
Bermagui	12,027	...	57
Tathra	23,764	...	141
Merimbula	13,857	...	119
Eden	15,863	...	68

New South Wales River Entrances.

River Entrance.	Depth on Bar L. W. S. T.			
	Prior to commencement of Works.		1916.	
	ft.	in.	ft.	in.
Tweed	3	0	5	7
Richmond	7	0	11	2
Clarence...	8	0	11	7
Bellinger	3	9	4	6
Nambucca	4	9	4	2
Macleay	5	0	7	0
Hastings	5	0	6	6
Camden Haven	4	6	6	3
Manning	8	0	10	5
Cape Hawke	2	3	3	0
Crookhaven	11	0	12	10
Bateman's Bay...	4	0	6	7
Moruya	6	0	9	5

Table V.—*Particulars of River Entrances of New South Wales.*

Name of Port.	Sailing distance from Sydney.	Total Length of River.	Limit of navigation for Boats drawing 4 feet.	Catchment Area of River.	Area of Tidal Compartment.		Proposed width of river entrance between Breakwater.	Depths during the year 1915–16 at Low Water Spring Tide.						Anticipated depth on completion of scheme.
								Maximum.		Average.		Minimum.		
								Bar.	Cros'ng.	Bar.	Cros'ng.	Bar.	Cros'ng.	
	Sea Mls	St. Mls.	St. Mls.	Sq. Mls.	Acres.	Sq. Mls.	Feet.	ft in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	feet.
Tweed	372	46	24	418	5000	8	500	9 9	8 1	5 7	6 3	3 8	4 9	9
Richmond	328	149	68	2683	6800	10½	1000	12 0	9 0	11 2	7 2	10 0	7 0	12
Clarence	294	247	67	8505	34000	53	1400	13 3	11 9	11 7	10 8	11 0	9 0	18
Bellinger	228	76	15	479	1640	2½	500	5 9	6 0	4 6	5 2	2 6	4 6	9
Nambucca	219	58	9	552	2730	4¼	500	5 6	7 0	4 2	4 10	2 6	3 6	9
Macleay	208	214	39	4581	3750	6	700	7 6	8 0	7 0	7 5	5 6	7 0	12
Hastings	112½	110	19	1389	6400	10	650	7 0	6 0	6 6	5 0	5 0	4 0	10
Camden Haven	159½	18	13	238	7240	11⅓	1600	7 3	5 9	6 3	4 11	4 6	4 0	8
Manning	141	141	29	3164	6800	10½	800	11 6	7 6	10 5	5 8	8 0	3 6	12
Cape Hawke	125	46	17	514	21930	34¼	400	4 0	7 6	3 0	5 5	1 6	3 0	9
Lake Macquarie... ...	50	...	...	291	26000	40½	...	9 6	5 6	5 2	4 5	4 0	3 3	
Crookhaven (including	71	205	22	2801	2808	4⅓	...	13 9	7 9	12 10	7 1	10 0	6 9	12
Shoalhaven River)	...		24	...	6533	10⅕								
Bateman's Bay	129	70	...	696	3750	6	950	9 0	...	6 7	...	5 6	...	10
Moruya	139	93	4	609	1550	2½	970	11 0	6 3	9 5	5 10	7 6	5 3	9
Wagonga	158	9	5	52	1650	2½	...	8 6	7 0	7 2	6 7	3 0	5 0	

cost of £33,433; this reduced the inflow of sand, and consequently the amount of dredging to maintain the requisite depth at the entrance. In 1909 it was discovered that the bar at the entrance consisted mostly of boulders, and not solid rock as previously supposed. These have been dredged up to the extent of 38,700 tons, with the result that an additional three feet six inches of water has been obtained; since this was achieved only ten vessels in four and a half years have had to leave the port without a full cargo, whereas in 1907 there were 45.

In the harbour improvements have been made. An up-to-date cargo wharf with sheds complete, known as Lee Wharf has been constructed, and a coal shipping wharf one-third of a mile long has been built on the western side of the Carrington Basin. Upon this have been installed six high speed electrical travelling cranes with a lifting capacity of 15 tons, at 55 feet radius, a hoisting speed of 100 feet, slewing 300 feet, and traversing 100 feet per minute. It is estimated with the improvement in the existing coal shipping appliances, and the recent additions, that in every day work, the appliances of the port at date could ship $9\frac{1}{2}$ million tons of coal per annum, as against the record shipment in 1913 of $5\frac{1}{2}$ million tons. With the removal of the Old Carrington and Darval Street bridges, good progress has been made with the dredging out of a second still water basin, by widening out Throsby's Creek. Additional mooring accommodation has been provided for loaded ships on the Newcastle shore, and three additional coal shipping berths have been provided between the two basins in connection with a proposed Bin and Conveyor system of coal shipment.

The expenditure on Newcastle harbour was, to the 30th June 1916, £946,238, the average annual cost of dredging and maintenance being over £50,000.

Sydney Harbour.

Twenty-five years ago practically the whole of the wharfage of the port was under private ownership. The State Government had built some wharfage at the head of Woolloomooloo Bay and round Circular Quay. Besides this, the next piece of Government wharfage was the iron wharf at the head of Darling Harbour. A start was about to be made at Darling Island on a frontage quay which was intended to connect it to the main land.

The private wharfage extended in an unbroken line from the west side of Circular Quay to the head of Darling Harbour. The majority of the wharves were jetties, narrow, without cover, and having from 80 to 90 feet of waterway between. There was an absence of system in the layout, many of them converging towards the outer ends so that they could not be lengthened without blocking access. The access from the shore was cramped and utterly inadequate; some of the wharves were reached by vehicular lifts which caused great obstruction to traffic.

With the increase in the size of vessels an impossible position was reached. Woolloomooloo and the Circular Quay could not furnish sufficient berthage. In addition, the private wharfage was in a gravely, insanitary condition, owing to the cheap and unsuitable construction of the sea walls and wharf sheds. The water front was infested with rats which became infected with plague introduced from foreign parts.

The whole situation in connection with the shipping was so bad, that in 1900 the Government decided to resume the whole of the wharfage along the city front from Woolloomooloo Bay to Darling Island. This was accomplished by Act of Parliament in the same year, the value of the properties resumed being £4,831,532. The resumption extended well back from the water front between Dawes

Point and the head of Darling Harbour to allow for a complete remodelling of the approaches, as well as the wharfage, and in 1901 the Sydney Harbour Trust was constituted and given control of the port.

When the Harbour Trust assumed control, the concrete sea wall at Darling Island was in course of construction, the eastern wall having been completed; the western and northern walls were carried out by them, and cargo sheds constructed for over-sea service as speedily as possible. A wharf at the north-eastern side of Woolloomooloo Bay, which had been commenced by the Public Works Department, was also finished. Plans were at once prepared for the remodelling of the wharfage and a roadway for access thereto, running along the foreshore from Circular Quay to the Gas Works, Darling Harbour. This is ultimately to be extended through the Gas Works to the head of Darling Harbour.

A commencement was made by the Harbour Trust in 1901 at Miller's Point, which then consisted of several ramshackle wharves. The first portion of the frontage roadway was opened up between Moore and Munn Streets in 1905, and a wharf 1,080 feet in length constructed along the shore.

The Trust next proceeded to demolish the old wharfage to the south of Miller's Point and north of the Gas Works, and reconstruct it on up-to-date lines. The frontage roadway was continued to the Gas Works boundary, and the land to the rear of Kent Street entirely remodelled. The wharfage in this vicinity now consists of five jetties, four of which are 500 feet in length by 100 feet in width, and one 600 feet long; four of them having double decked cargo sheds. Further progress is at present blocked by the Gas Works, but this property has been resumed by the Government, and it is expected that the new frontage

roadway, called Hickson Road, after the first President of the Trust, will be opened through into Sussex Street this year.

East of Miller's Point the old wharfage has been demolished as far as Dawes' Point, and eight new berths have been completed. These consist of two frontage wharves and three jetties. These berths range from 500 feet to 700 feet in length. The water front at this locality was the most inaccessible portion of the original wharfage, the demolitions, necessary to open up the frontage roadway (Hickson Road) were very considerable, and a great amount of quarrying was necessary. Hickson Road was carried by cutting through the hill to meet the portion constructed earlier, north of the Gas Works; this entailed the removal of an enormous quantity of solid rock and the construction of three reinforced concrete over-bridges; at present the road is open from Dawes' Point to the Gas Works.

The wharfage at the eastern side of Wooloomooloo Bay, which was comparatively new when the Trust took charge, proved to be unsuitable for the accommodation of modern vessels and had to be extended; the deck level was raised, and large modern cargo sheds erected.

To make the most of the available space at this part of the harbour, a jetty was built extending north from the centre of the bay a distance of 1,160 feet, and 208 feet in width. It is provided with a central roadway four feet below the floors of the wharves, and double decked cargo sheds in which electrical cargo handling appliances are installed.

At Pyrmont a jetty for the shipment of grain was built 1,000 feet in length and 150 feet wide. The structure of this jetty is very heavy as it is frequently loaded with wheat in bags stacked 27 feet in height above the deck.

An important group of wharves was recently commenced at Jones Bay, Pyrmont, and is now nearing completion. The eastern jetty of this group is of novel construction, being built of a combination of timber, steel and concrete.

At Glebe Island a large amount of reclamation has been carried out, and 1,000 feet of timber wharf built in connection with the grain trade of the port. This will, in all probability, be incorporated in the proposed Bulk Grain Handling Scheme later on.

The ferry jetties at the Circular Quay and Erskine Street have been rebuilt to suit the ever increasing traffic. The outlines of the Circular Quay have been greatly altered, there now being fewer berths than of old, but of greater length and superior cargo shed accommodation.

On the Trust's property outside of the wharfage premises a great deal of remodelling has been done. Numerous old shops, residences, hotels, stores and workshops built by private persons have been demolished. New streets and lanes have been opened and old streets such as Sussex and Argyle Streets widened.

Since its inception the Trust has spent £3,316,073 on the improvements of the port, streets, buildings, etc., bringing the total capital value up to £8,147,605.

The eastern channel at the entrance of the port has been deepened from about 30 feet twenty-five years ago to 40 feet, for a width of 700 feet. The western channel has also been cut through on one side, and work is proceeding towards securing 40 feet in it also for the same width; soundings show that these channels do not tend to fill up by silting after being dredged to the increased depth.

The use of reinforced concrete for the construction of the large pontoons for the ferry wharves introduced a few years ago by the Engineer-in-Chief, Mr. H. D. Walsh,

M. Inst. C.E., has been found most suitable, and the same material was used for the protection of the piles for the long jetty at Woolloomooloo Bay and the eastern jetty at Jones Bay.

The lights connected with the navigation of the port have been rebuilt, those on land being with few exceptions constructed of reinforced concrete, and all except a few lighted with acetylene gas; the floating lights are also fitted with occulting acetylene gas apparatus.

Gas Works.

The importance of gas in our daily life was fully realised recently, when owing to a shortage in the supply of coal its use had to be restricted, thus causing inconvenience to thousands of householders. In this State the public supply of gas dates back to 1842, when the Sydney works were first put into operation; from then until 1891 the demand for light and power had grown to such an extent that the Australian Gas Light Company, who supply Sydney, had found it necessay to build works at Mortlake, which were put into operation in 1886. They were fitted with all the labour saving devices available, that being the first occasion in Australia when the retorts were charged and drawn by mechanical power, thus relieving the stokers of a portion of their arduous labours, and so satisfactory were the results, that the head station at Kent Street, was in 1896, equipped with similar machinery at a cost of £40,000. By 1895, the 36 inch main from Mortlake into the city had become too small. To increase its capacity the gas was forced along it at high pressure, and to regulate the supply to the various districts, governing stations were erected at the points of offtake; a second main has since been laid.

Up to 1913, horizontal retorts had been used for the carbonization of coal, but at that date the vertical retorts were first used in the State, the Newcastle Gas Company

abandoning entirely the old type; the Australian Gas Light Company were, however, unable to discard the older type, but their extensions at Mortlake in 1913 were of the vertical type in which the coal is fed in at the top and the coke discharged at the bottom. Further extension has since been made, and now 50% of the gas produced at Mortlake is made in vertical retorts.

The new works of the North Shore Gas Company, the completion of which has been delayed by the war, will have vertical retorts.

This type of retort requires the coal to be raised to hoppers at the top, which is done by an extensive system of electric telpherage, the coke discharged automatically from the retorts is also handled by the same means; the complete system was put into operation at Mortlake in 1915.

The company have at their various works and depôts storage capacity for 20,000,000 cubic feet of gas; the holder recently constructed at Mortlake holds 12,000,000 cubic feet and is the largest in the Empire, a larger one near London having been destroyed during a Zeppelin raid.

The tar produced is distilled in accordance with the War Precautions Act requirements, but up to the present no attempt has been made on a commercial scale to go beyond this.

Both at Mortlake and Kent Street the company have installed plants for the manufacture of carburetted water gas, the capacity being three million and one million cubic feet of gas per day respectively.

The Australian Gas Light Company's progress during the last quarter of a century has been followed throughout the State, the industry showing remarkable progress. Tables VI and VIA have been compiled from data in the Gas World Year Book, and show that in the fourteen years from 1902 to 1916 the quantity of gas made has increased 300%.

Table VI.—*Gas Works Owned by Municipalities.*

Name of Town.	1902		1916	
	Annual make in millions of 1000 c.ft.	Number of Consumers.	Annual make in millions of 1000 c.ft.	Number of Consumers.
Armidale	...	...	11	570
Bathurst	36	1400	63	2239
Bega	2	100	3	190
Bowral	...	...	4	192
Cootamundra ..	...	...	10	394
Dubbo	4·6	300	12	530
Forbes	...	...	8	395
Glen Innes ...	1·5	115	8	358
Lismore	...	...	26	880
Lithgow	7	295	43	1215
Liverpool ...	...	..	7·5	272
Maitland, East ...	...	200	8·8	474
Molong	...	...	2	160
Muswellbrook ..	2	90	6	340
Nowra	...	...	4·5	205
Orange	12	586	35	1106
Parkes	...		6	255
Wagga Wagga ...	7·9	380	18	760
Waratah	6·8	238	24	1050
Wellington ..	...	...	8	418
Yass	...	...	3	141

Table VIA.—*Gas Works Owned by Companies.*

Name of Town.	1902		1916	
	Annual make in millions of 1000 c.ft.	Number of Consumers.	Annual make in millions of 1000 c.ft.	Number of Consumers.
Albury	5	250	8	400
Bathurst	...	...	9	250
Broken Hill ...	10	492	44	2353
Camden	...	...	5	175
Casino	...	...	7·8	363
Cowra	...	..	10	239
Goulburn	15	600	24	716
Grafton	5	...	14	392
Grenfell	...	...	5·5	220
Hay	...	...	4·5	461
Katoomba	...	...	30	1150
Kiama	2·5	83	4	135
West Maitland ...	18	600	40	2700
Manly	...	...	95	3196
Mudgee	...	...	6	405
Newcastle	82	3400	262	10727
Singleton	...	...	9	431
Sydney	1668	53000	4403	129440
North Sydney ...	153	4633	748	18140
Tamworth	6	456	11	520
Wallsend	...	...	9	483
Windsor	...	...	3	136
Wollongong ...	7	260	19	672

The recent resumption by the Government of the Kent Street Works for harbour improvements, has compelled the Gas Company to largely extend their Mortlake works and very shortly the whole of the gas supplied by them will be manufactured there.

Electric Lighting.

In 1891 the public supply of electricity was only in its infancy, the plant installed having a total capacity of 600 kw., since then there have been wonderful developments, not only in Sydney but throughout the State.

Table VII shows the towns in which works for the public supply of electricity have been established.

Table VII.—*Electric Light Stations in New South Wales 1916.*

Under Municipal Control.

Albury	Petersham	Moss Vale	Sydney
Broken Hill	Goulburn	Newcastle	Tamworth
Cowra	Inverell	Penrith	Temora
	Young.		

Privately Owned.

Ballina	Deniliquin	Kempsey	Narrandera
Balmain	Dungog	Lismore	Parramatta
Bulli	Holbrook	Manilla	Walla Walla
Cobar	Gunnedah	Manly	Windsor
Culcairn	Henty	Moree	Wingham
Coonamble	Katoomba	Mudgee	Wollongong
	Yanco and Leeton.		

The greatest development has, however, taken place in Sydney, where the City Council in 1904, established works for the supply of current for public and private lighting and power. So successful was it from the first, that extensions were required almost at once, the growth has been continuous at an increased rate, and has only been checked by the Council being unable to obtain the necessary machinery in consequence of the war.

The Power House, admirably situated for convenience of the supply of fuel and condensing water, is at Pyrmont near

Darling Harbour, with the railway alongside, but the demand for current has extended to such a distance from the city proper that it is no longer central.

The generating plant first installed consisted of three reciprocating steam engines driving three-phase alternators of a total capacity of 1500 kw., generating a current of 5000 volts 50 cycles per second. In 1906 additional machinery of 1200 kw. capacity was installed, in 1907 a steam turbine driven generator of 2000 kw. was started and duplicated in 1908. This did not suffice for long, as in 1911 two similar plants, but each of 4000 kw., were found necessary, and in 1914 a 5000 kw. turbine driven generator was added, this being of German make, and I am pleased to be able to say that those of British make previously supplied, have, I believe, proved themselves superior machines.

Some of the earliest installed plant has been sold, being too small to operate economically, the plant having thus grown from a capacity of 1500 kw. in 1904 to 26200 kw. in 1914, when its growth was checked.

Steam is generated in boilers of large capacity fitted with automatic chain grate stokers, and superheaters.

The coal used is delivered by railway waggons into hoppers after having been weighed, and from there raised to an overhead coal bunker from which it is delivered by gravity to the automatic stokers, being weighed on its way, so that the performance of each boiler on each shift can be checked.

The ashes are handled by conveyors and elevators and delivered into overhead hoppers, from which they are discharged by gravity into railway waggons.

The high tension switch gear is arranged in special chambers under the engine-room floor, and is operated

electrically from a platform in the engine room, the risk of accident to the operator being practically done away with, as he has not to handle the actual switch.

The 5000 volt three-phase current generated at the power house is for the centre of the city proper, conveyed by lead covered cables to substations, where it is converted by motor generators to 480 volt direct current and supplied to consumers either at 480 or 240 volts. For all outside this area the current is transformed by static transformers to 415 volts, giving 240 volts to the neutral wire.

The extension of the area of supply was such that in 1910 it was found necessary to increase the pressure for the more distant suburbs to 10,000 volts, and afterwards to 10,500 volts; this, however, was not sufficient, and the pressure has been raised to 33,000 volts, current at that voltage being supplied to works at Granville and the Abattoirs, and will, as soon as material is available, be taken across the Parramatta River to the distributing station for North Sydney.

Besides the City of Sydney current is supplied to the following municipalities: Alexandria, Annandale, Auburn, Botany, Burwood, Canterbury, Concord, Darlington, Drummoyne, Enfield, Erskineville, Glebe, Homebush, Lane Cove, Lidcombe, Marrickville, Mascot, Mosman, North Sydney, Paddington, Randwick, Redfern, St. Peters, Strathfield, Vaucluse, Waterloo, Waverley, Willoughby, and Woollahra, the relative number of consumers in the suburbs being 15 to 10 in the city.

The municipalities on the north of the harbour are at present supplied through a submarine cable; the City Council have, however, erected on the banks of the Parramatta River, at Abbotsford and Gladesville, steel towers about a third of a mile apart, from which the cables will be suspended at a height of about 150 feet above the surface of water.

The extension to the outlying suburbs has made necessary a very considerable increase in the substations; in 1904 there were five, in 1907 eight, in 1910 seventeen, in 1913 sixty-three, and at the present time about one hundred, besides a large number of pole transformers. The capital expenditure, which at the end of 1904 amounted to £151,894, has grown until at the end of 1916 it was £2,860,000.

The Electric Light and Power Supply Corporation was formed in 1908, they built works on the water side near the Iron Cove Bridge at Balmain, in order to carry out a contract entered into with the Balmain Municipality to supply electric current, and also destroy their garbage, the waste heat from this being used for the generation of steam. The supply which has been extended to the adjoining municipalities of Newtown, Petersham, Leichhardt and Ashfield, commenced in September 1909, since which time the success of the company must be most gratifying to its shareholders and officials.

The power station is equipped with two reciprocating triple expansion engines and three steam turbines driving generators of 5050 kw. total capacity, supplying an alternating three-phase current at 5000 volts which is conveyed to twenty-two different transformer substations by bare overhead mains and from them supplied to consumers at 415 volts.

The area within which the company has the sole right to supply electric light and power covers ten square miles with a population of 146,000, the street mileage being 212, number of premises, including many large factories, 29,762, with a capital value of £17,620,741.

The expenditure to October 1916 amounted to £266,951; 116 miles of streets being lighted, of which 98 miles are reticulated for private lighting, the high pressure trunk mains from the power house to the district substations amounting to 33 miles.

Water Supply.

A plentiful supply of potable water is one of the necessities of life, and as settlement increased, became one of the most pressing problems of the State. In 1891 the requirements of only the larger towns of the State had received attention, but the growth of population, the increase in the standard of living, and above all the necessity for better sanitation, have been the cause of a large extension of public water supplies within the past twenty-five years.

The Country Towns Water Supply and Sewerage Act, which was passed in 1880, and enabled the Government to carry out works for country municipalities, has been taken advantage of by fifty-five municipalities not including Sydney, Newcastle, and Broken Hill. Of these, the works of eight of the larger towns had been constructed prior to 1891, but have since that date been considerably extended.

The total expenditure on these works has been £1,201,547, of which £258,630 was expended prior to 1891.

The population of the eight country municipalities with water supplies constructed prior to 1891, was in 1890, 43,328 and in 1914, 55,750, an increase of only 1·2% per annum.

The water supply of Sydney and the surrounding suburbs was in 1891 only in process of development. From very early days it had been a problem always facing those responsible for the welfare of the State, and soon after a new scheme or extension was completed, the need for an additional supply arose.

In 1891 the storage capacity available to tide the city over droughts was limited to that at Prospect Reservoir, which when full covers 1,261 acres, and holds 10,812,313,000 gallons. In order to maintain the supply in Sydney and the surrounding suburbs, service reservoirs had been built in the various districts at such elevations as were necessary,

the highest one being at Chatswood, 370 feet above sea level; they had in 1891 a capacity of 15,710,000 gallons, exclusive of Potts' Hill balance reservoir, which holds 100,000,000 gallons, and is now being extended.

Only two of them, containing 3,400,000 gallons, are at a sufficiently low elevation to be fed by gravity from Prospect, the water having to be raised by pumps to the others.

In 1894 the large reservoir in Centennial Park, which has a capacity of 17,000,000 gallons and a top water level of 245 feet, was completed, and the Paddington reservoir abandoned. The growth of population on the South Coast line required additional storage capacity, and a steel tank holding 1,000,000 gallons was erected at Penshurst, and the rapid development along the Milson's Point-Hornsby railway line necessitated the construction of a tank holding 1,000,000 gallons at Wahroonga at a height of 720 feet above high water mark.

The capacity of the service reservoirs is now over 58 million gallons, the highest one being 776 feet above sea level.

The Metropolitan Board of Water Supply and Sewerage, who control the supply to Sydney, had since their incorporation in 1888 been vigorously extending the area reticulated, but no steps were taken to increase the supply until 1899, when the low level of the water in Prospect Reservoir caused them to make inquiries as to the facilities for the storage of additional water, and surveys were made of the catchment area to discover suitable sites for this purpose.

Early in 1902, the withdrawal of water from Prospect Reservoir had lowered the level below that necessary for gravitation to Sydney, and machinery had to be provided for raising it into the supply channel. As a result of this shortage, the Government determined to proceed with the construction of a dam on the Cataract River to supplement

the storage in Prospect Reservoir; this was finished in June 1908 and handed over to the Board.

This dam, one of the finest in the world, is built of Cyclopean masonry, and has a height of 160 feet, impounds 2,411,000,000 gallons of water, and cost £325,000 to construct; the full supply level is 950 feet above the sea.

The quantity of water contained in Cataract and Prospect reservoirs was sufficient for some years, but increasing demands and an absence of rain on the catchment area recently caused a shortage of water, which is to be obviated by the construction of a dam on the Cordeaux River, and it is to be hoped that its completion will temporarily provide for the supply of the city and suburbs, which are growing so rapidly, that any scheme of water supply to be satisfactory must provide for frequent extensions; in fact nearly as soon as one reservoir is completed investigations as to the site of another one should be taken in hand.

Table VIII shows the length of mains, quantity of water supplied, and population in 1891 and 1916.

Table VIII.—*Water Supply.*

	Sydney.		Newcastle.	
	1891	1916	1898	1916
Length of mains in miles	640	2,345	171	412
Properties connected to mains ...	76,093	183,598	7,315	22'370
Population served	365,246	918,000	36,600	112,000
Water delivered per annum in million gallons	3,482	14,374	285	1,283
Per day	9·54	39·38	0·781	3·5
Per head, gallons	26·11	42·89	20·89	31·80

The Hunter River District Water Supply works were completed in 1887, and handed over to the Board who now control them in 1892; since that time no large works, except the extension of mains and several service reservoirs, have been constructed, but the increase in the population and manufactures has for many years rendered the supply

inadequate during dry summers. However, a scheme which will give the district a plentiful supply of soft water has recently been commenced; the data as to mains etc., are contained in Table VIII.

The Broken Hill Water Works were constructed by a private company, who in 1893 commenced to supply water obtained from a reservoir formed by an earthen dam in Stephens Creek, about ten miles from the town, from where it was pumped to a service reservoir in Broken Hill. The district has a small annual rainfall and is subject to heavy storms, the result being that the water conserved becomes turbid; to overcome this the company, in 1897, installed a rapid filtration plant, the result being that the supply was rendered satisfactory.

The evaporation from the surface of the large reservoir formed by the dam in Stephens Creek is very great. During the fifteen years ending 1907, the total supply sold amounted to about 2,300 million gallons, and the evaporation from the surface to about 17,750 million gallons, nearly eight times the quantity utilised.

A second works for the supply of Broken Hill has been constructed by the Government, a concrete dam having been built across Umberumberka Creek near Silverton, nineteen miles from Broken Hill, from there the water is pumped to the town; this was completed in 1915 at a cost of £462,511. On the completion of this work the Government took over the works of the Stephens Creek Company, and now supply the town and mines from both sources.

Sewerage and Drainage Works.

The introduction of the biological system of treating sewage, placed sewage works within the reach of many of the country municipalities, and fifteen towns which had a water supply, have been sewered by the Government on

behalf of the municipal councils; up to the end of the last financial year £338,314 had been spent on this work; this includes Parramatta, which cost £66,010, and has since been transferred to the Metropolitan Board, but does not include Sydney and Newcastle.

All these works have been carried out since 1901, besides the fifteen country towns which already have sewerage works. Progress has been made towards the completion of the schemes in Orange, Goulburn, and Albury.

The City of Sydney in 1891 had a complete sewerage works in operation, except in the low lying areas, but outside the city and the nearer suburbs very little had been done with the reticulation, but the main sewers were in progress. The number of properties liable for sewerage rates at the end of that year were 31,807. By the end of June 1916, this number had increased to 129,650 houses, serving an estimated population of 650,000. Naturally from this great increase it follows that the length of main sewers and reticulation has also increased; in 1891 the total length of sewers under the Board's jurisdiction was 149 miles, and at the end of June 1916 the length had become 1,022 miles, a much greater rate of increase than that of the population served.

Until 1916, the sewage from the south side of the harbour was discharged, either into the ocean at Bondi, or after treatment, at the Sewage Farm at Botany, which had an area of 620 acres, into Botany Bay. For some years previously, complaints had been made as to the nuisance arising from this farm, and in 1907 a scheme for an ocean outfall in substitution for the sewage farm, was submitted to Parliament and approved. After exhaustive observations of the coastal currents, the most favourable point for the sewer outlet was found to be on the northern headland of Long Bay, as the southerly current at that point would sweep the sewage to sea clear of the land to the south.

The sewer, which is one of the largest in the world, is six and a quarter miles long, its greatest width being twelve feet three inches, and greatest height nine feet; it drains an area of 38,000 acres, which includes some of the closest settled suburban districts, with an estimated population of 300,000; the gradient of the sewer is very flat, being only 1 in 3650 from the manhole at the syphon under Cook's River to the outfall.

The wastes from the woolscouring works and tanneries at Botany, which were formerly discharged into Cook's River, are now turned into the sewer, thus removing a source of pollution from the river which was causing trouble. The sewer was completed in 1916 at a cost of £516,158.

Many engineering difficulties were met with in its construction, especially where it passed through wet sand, which was in the deepest part of the cutting, at a point where the invert of the sewer is 68 feet below the surface.

A number of constructional difficulties were encountered in forming the outlet channels to the ocean, special contrivances being required to prevent the waves rushing up the sewer. A large air chamber with a shaft to the surface was constructed a hundred feet back from the edge of the ocean cliff. The bottom of the sewer at this air chamber is two and a quarter feet below spring high-water level. The sewer discharges into a basin constructed with wave traps, from which two channels have been driven, diverging like the sides of the letter "V," and dipping so that they run out into the ocean from the face of a submerged cliff 300 feet from the shaft, at such depth as to give twenty-three feet of water above the top of each outlet at spring tide. The rock through which these channels were driven proved sound and free from fissures, so that tunnelling was carried on without difficulty within five feet of the ocean. The tunnels having been lined with concrete, a number of

holes twelve inches apart were drilled in the rock round the circumference of each tunnel face, to within eighteen inches of the water. Two large centrally situated holes were also drilled, and all the holes charged with gelignite. Detonators with copper wires were inserted, and connected with cables running to a battery above high-water level. The water was then slowly admitted from a hole driven through the face into the sea, until it rose in the tunnel to the level of the ocean, and when the water pressure on both faces of the rock partition became equal, the charges were fired. Weather conditions being favourable, a diver descended from the end of the wall under which the tunnels were driven. In the case of one tunnel he found the outlet clear, the rock having been cleanly cut out, and blown outwards. The other tunnel, while the explosive had done its work effectively, was blocked with large fragments of rock, which remained lodged in the tunnel mouth. These masses of rock had to be drilled under water and broken up with explosives before the tunnel mouth could be cleared.

The sewage on the northern side of the harbour is dealt with at Chatswood, Balmoral, and Folly Point by septic tanks and filters, the effluent being discharged into branches of Middle Harbour. The Folly Point works were originally constructed to treat sewage by lime precipitation and subsequent filtration; soon after completion the method was altered, the precipitation tanks being converted into septic or liquifying tanks, and a portion of what were originally sand filters converted into percolating filters.

Recently exhaustive experiments have been made with a new method of sewage purification termed Sludge Activation, and I understand that the system is about to be used at Folly Point instead of the septic or liquifying tanks, as the experiments have demonstrated that it is more effective, and possibly causes less annoyance to those living in the immediate neighbourhood of the works.

Water Conservation and Irrigation.

The importance of water conservation is shown by the number of valuable papers upon it to be found in the proceedings of our Society.

It is difficult to say when irrigation actually commenced in New South Wales, for although dates can be given for the passing of the various legislative enactments, such as the "Water Rights Acts," the "Hay Irrigation Act," "Wentworth Irrigation Act," and the "Irrigation Act, 1912," constituting the Water Conservation and Irrigation Commission, there were, previous to the passing of any of these Acts, numbers of private individuals in the State who were diverting or pumping water from the various streams and rivers in the State, and utilising it for irrigation purposes in their private capacity. One of the main reasons for passing the Water Rights Act of 1896 was to secure land holders in possession of duly authorised works. Prior to that date any man considering himself aggrieved by the existence of any such works could either bring a suit in Equity or take the law into his own hands, and cut away the dam or work of his neighbour. Under the Water Act all works of this nature are licensed. The first of such licenses was granted in 1897. Since that date upwards of 2,000 have been issued, of which 688 are for irrigation purposes, no less than 219 new licenses having been applied for last year. The whole of these licensed works are not used for irrigation, but, on the other hand, there are many instances where pumps have been licensed with a sufficient capacity to irrigate several hundred acres, and it is estimated that private irrigation areas amount to 30,000 acres.

Realising the importance of water conservation and irrigation to develop agriculture in the semi-arid parts of the State, the Government have taken active steps to extend its benefits. The possibilities of the regions of

limited rainfall, when artificially supplied with water, have been known from the earliest times, but New South Wales, and in fact, the whole Commonwealth, have until lately lagged behind in making use of their arid and semi-arid lands, but greater interest is now being taken in the subject. The first attempt on the part of the Government of the State to introduce a system of irrigation, was made in the year 1890, when the Act constituting the Wentworth Irrigation Area was assented to. This constituted a Trust under the control of the local Municipal Council, embracing an area of 10,600 acres, of which about 1,500 acres are irrigable; it was, however, not successful, and in 1906 the control of the area was vested in the Department of Agriculture, until the 1st July, 1913, when under the Irrigation Act the Water conservation and Irrigation Commission assumed control. It has been a pronounced success. Under the original Trust a number of the blocks were taken up, there being 27 settlers in 1906; three years later the number had increased to 58, and at the present time there are about 80 settlers holding the bulk of the irrigable and non irrigable land available on the settlement. At the present time they produce fruit and other agricultural produce to the value of at least £20,000 per annum. The area under irrigation is only about 1,200 acres, which would under ordinary conditions in the Wentworth district maintain 400 to 500 sheep; it can readily be seen what a wonderful difference the application of water to this small patch of the arid waste has made to the district.

The history of the Hay Irrigation Area, which was established under a separate act in the year 1897, is somewhat different to that of the Wentworth scheme. The Wentworth settlers having Mildura as an object lesson almost at their door, devoted their attention largely to the production of fruit, which is disposed of largely in the dried condition. At Hay on the other hand the settlers have

concentrated their attention upon the production of milk, and other dairy produce for local consumption, the land being of a type considered unsuitable for the growth of fruit trees, although with irrigation, it can be made to produce satisfactory fodder crops. The control of this area was in 1913 handed over to the Water Conservation and Irrigation Commission; it consists of only about 970 irrigable acres with added dry areas, totalling slightly over 4,000 acres, on which are about 80 settlers.

Both the Hay and Wentworth areas, however, dwindle into insignificance compared with the Murrumbidgee Irrigation Areas, which are at present passing through the minor troubles incidental to such a scheme, but which at the same time give promise of developing into prosperous and contented settlements.

This scheme was talked of by politicians and discussed in the public press for many years before it actually came into being. It involved the erection of a storage dam in the Murrumbidgee Gorge at Burrinjuck, capable of holding upwards of 750,000 acre feet of water, and the development of a complete settlement to contain 100,000 people on the plains of Narrandera, which were, practically speaking, uninhabited.

So much has been written of the great dam at Burrinjuck, that it is perhaps unnecessary to refer to the matter at length here, but the following figures as to its dimensions will, no doubt, be of interest.

The length of the crest of the dam exclusive of curvature, will be 752 feet. Its height from the lower level of the foundations at R.L. 949·53 to the top of the parapet, will be about 236 feet. Its greatest width at the base is 168 feet, at the top 18 feet. On either side there will be two spill-way weirs several hundred feet in length. The surface area will be no less than 12,784 acres when the reservoir

is full, and it will then contain 33,612,671,000 cubic feet. After being released from the dam, the water passes down the Murrumbidgee River for upwards of 200 miles until reaching Berembed, near Narrandera, where a portion of it is diverted by a subsidiary weir, and works into the main irrigation canal, and the balance allowed to flow down the river to serve riparian interests. After passing for about 40 miles along the main canal on the north side of the river, the water reaches the Murrumbidgee Irrigation Areas, where it is distributed amongst the various settlers; large pastoral holdings having been resumed by the Government for that purpose. It is estimated that the water stored in Burrinjuck will irrigate about 200,000 acres, which it is proposed to subdivide into about 6,000 farms. At the present time approximately 1,000 farms have been taken up, and the amount of fruit produced is already a very considerable item in the State's production. It is estimated that next season the production of the Murrumbidgee Irrigation Areas, in peaches alone, will amount to from 3,000 to 5,000 tons, and before very long the quantity of citrus fruits and grapes will be of similarly large dimensions.

The output of the Leeton Butter Factory is between three and four tons per week. A large bacon factory has been established, and a cheese factory is also in operation at Mirrool, while to handle the large output anticipated in the near future, several other factories are projected in addition to the one already in operation at Leeton.

Iron and Steel Industry.

No description of engineering progress in this State for the last quarter of a century would be complete without a reference to the iron industry. Started in a small way at Mittagong in 1848, and meeting with many vicissitudes, it is now well established, there being in regular operation two large works, one at Lithgow belonging to Messrs. G.

and C. Hoskins Ltd., and the other at Newcastle, the property of the Broken Hill Proprietary Co.

The materials required for the manufacture of pig iron at Lithgow are all obtained from within the State, iron ore from Carcoar and Tallawang, distant 96 and 128 miles respectively from Lithgow, limestone from Ben Bullen and Havilah, 27 and 85 miles respectively from Lithgow, coke from the South Coast and their own works at Lithgow, whereas the Broken Hill Proprietary Company bring the iron ore from South Australia, where they have an enormous deposit of suitable ore containing a high percentage of oxide of iron, the ships returning to Port Pirie in South Australia with coke for the silver lead smelters.

The first blast furnace at Lithgow was put into operation in 1875 and ceased work seven years later; in 1886 Mr. Sandford took over the works and rolled bars made from scrap and imported material. It was not, however, until 1906 that he erected the first of the two blast furnaces now in operation, the iron work and machinery in connection with it having been manufactured in England. It was blown in in May 1906, and at the end of 1907 these works came into the possession of their present owners, Messrs. G. and C. Hoskins Ltd., who installed additional steel furnaces, rolling mills etc., and greatly extended and remodelled the plant. In 1913 they erected a second blast furnace with all the necessary adjuncts of heating stoves etc.; the iron-work for this addition, instead of being imported, was made by themselves, chiefly at their Sydney works. These two furnaces have each a capacity of 300 tons of pig iron per week, part of which finds a ready sale to iron-founders throughout Australia. A considerable portion is, however, used by the firm at their own foundries in Sydney, and the balance is made into steel by the open hearth process, and rolled into rails, bars and sheets. The works also contain

a plant for the manufacture of galvanized corrugated and plain sheets.

Much of the machinery used at Lithgow has been constructed by the firm, and the remainder imported from England. Economy in working has been studied, with the result that what was formerly a languishing industry is now flourishing, and the source of employment to a large body of men.

The steel works of the Broken Hill Proprietary Company are at Newcastle on the bank of the river Hunter. The site although most suitable, required very extensive piling to carry the heavy weight of the furnaces and machinery, 225 piles being driven for the foundation of the blast furnace. The works have been laid out so that they can be readily extended, and still maintain the proper sequence from the receipt of the raw material to the delivery of the finished product.

To fully describe these works would require more time than is at my disposal; in them is embodied every means to economise labour and to perform by machinery those laborious duties previously carried on by human exertion, in close proximity to white hot metal. One of the most interesting sights is to see huge machinery, requiring some thousands of horse power to drive, it being instantly started, stopped and reversed in direction by the movement of a small lever.

The molten iron from the blast furnace is not allowed to cool, but delivered directly to the steel melting furnace, and waste heat from the furnaces is used to heat the blast, and to raise steam in the boilers so that the cost of fuel is reduced as far as possible.

The machinery was imported from America, and at the present time comprises blast furnace with a daily capacity of 500 to 600 tons, seven steel furnaces of 60 to 70 tons per

furnace, blooming mill 300 tons per shift, rail mill 150 tons per shift, 18 inch mill 100 tons per shift, coke ovens, of which 66 are in operation, producing 350 tons of coke per day, and 3,600 gallons of tar and five tons of sulphate of ammonia.

The steel produced is of an even quality and has been found very suitable for shell making, large quantities having been sent to England for that purpose during the war.

Portland Cement and Lime.

Of scarcely less importance in modern engineering works than iron, is cement and lime. New South Wales is favoured with inexhaustible supplies of high grade limestone suitable for the manufacture of Portland cement and lime, together with numerous and extensive deposits of marble, beautifully coloured and figured, eminently suited for ornamental and decorative uses, notably in the vicinity of the Mudgee railway line, where supplies of limestone, shale and coal occur in close proximity, and represent ideal sites for the manufacture of Portland cement.

Portland cement was first manufactured in New South Wales at Portland about thirty-five years ago by the Cullen Bullen Lime and Cement Company. Official figures as to their production are not available, but the output was limited.

At that time the mixture of limestone and shale was burned in stationary kilns, and the clinker ground between millstones. The progress of the industry since then has been phenomenal, due chiefly to the improved methods of manufacture and the increased demand for cement. The successful improvements made in grinding machinery—the old mill-stones being replaced by ball-mills, tube-mills, comminuters, griffin-mills, etc., have been the means of enormously increasing the capacity of a plant and lessening the cost of production.

About 1889 Goodlet and Smith erected an up-to-date plant at Granville, and in 1901 the Commonwealth Cement Company, having taken over the Cullen Bullen property, erected a 20,000 ton capacity plant at Portland. Since then both companies have kept pace with modern requirements, replacing obsolete with the latest machinery, and enlarging their plants to meet the ever increasing demand for cement, until now their capacities aggregates nearly 200,000 tons per annum. The Commonwealth Company produce 150,000 tons, and Goodlet and Smith's 40,000 tons.

In 1916 the New South Wales Lime and Cement Company erected a modern plant at Kandos, on the Mudgee line, which has a capacity of 30,000 tons per annum, and this I believe is to be increased to 60,000 tons.

Another company—The Vulcan Portland Cement Company—are about to erect a plant at Brogan's Creek; war conditions have, however, interfered with their arrangements to have the machinery installed in 1915.

A certain amount of cement has been imported each year, ranging from 5,500 tons in 1908 to 30,000 tons in 1912, but with the erection of two new plants, and the enlargement of existing ones, the local production should cope with the demand for some years to come.

The process of manufacture adopted is that known as the "Dry Process," in which the raw materials are roughly crushed and dried separately, then mixed together in their proper proportions, and after further grinding and mixing to reduce it to a very great degree of fineness, and thoroughly mixing it so that the composition is homogeneous, it is calcined in rotary kilns at a temperature of about 3,000° Fah. and the resulting clinker ground to the requisite fineness.

These rotary kilns, seven to eight feet in diameter, consist of a steel jacket and firebrick lining, set at such an angle

to the horizontal, and of such lengths, as the extent of the output requires; the raw materials after the final mixing are fed into the upper end, and coal ground to a fine dust is blown into the kiln at the lower end, the ground material thus travelling in an opposite direction to the gases resulting from combustion.

The largest of the works, (that at Portland, erected in 1901), has a capacity of about 150,000 tons per annum; the raw materials, limestone, clay and shale are obtained in the immediate neighbourhood of the works, and coal from collieries close by. The plant, which is most extensive, is driven either directly, or by motors supplied with electric current generated in the power house at the works by steam engines totalling 6,500 horse power.

The rotary kilns vary in length, there being three 65 feet, one 80 feet, one 100 feet, one 125 feet, and one 155 feet in length, the kilns having been increased in number and length as the business has expanded.

The works at Kandos are the most recently erected and have a yearly capacity of 30,000 tons of cement; clay and coal are obtained at the site of the works, and the limestone from quarries about three miles away; the whole of the machinery is electrically driven, the current being generated by steam turbines.

Goodlet and Smith have recently discarded their steam engines and boilers, and are using electric current supplied by the City Council at 33,000 volts for driving all the machinery. They are, I believe, the largest consumers of power for any one industrial undertaking supplied by the City Council.

Lime.

The progressive spirit so marked in the manufacture of Portland cement is somewhat lacking in the lime industry, probably due to the relatively small demand for lime enabling the antiquated methods to cope with it.

Most of the lime produced here is burned in "intermittent" kilns of the D type, which are somewhat primitive when compared with the more modern type of kiln operating in other countries. Recently, however, two modern producer-gas continuous kilns have been erected, and probably as the demand for lime increases the wasteful D kiln will be replaced by others more up-to-date.

Up till 1914 each year showed a small progressive gain in the amount of lime manufactured, increasing from 18,000 tons in 1908 to 36,207 tons in 1914. Since then, however, owing to war conditions, building operations have been considerably curtailed and the lime industry has suffered—the production in 1916 totalling only 26,500 tons.

With a return to normal conditions, entailing an increased demand for lime for building, agricultural and chemical purposes, an increased production is assured.

Marble.

A display of New South Wales marbles was made at the Franco-British Exhibition in London in 1908, and was awarded the Grand Prize, while at the Panama Pacific International Exposition at San Francisco in 1915 a similar exhibit was awarded "Medal of Honour," in both cases the juror speaking in the highest terms of our marbles.

While there is no question as to the general excellence of our coloured marbles, including all shades of red, pink, blue, grey, dove, ivory, black, etc., and handsome breccias, unfortunately the deposits of white marble so far exploited have been either too coarse or not sufficiently uniform in texture for sculptural and monumental work, and do not compare favourably with Carrara, Grecian or American white marbles.

Although attention has been directed to these deposits since the early days of the State, it is only within the past few years that determined efforts have been made to

establish a local industry. The majority of our marble quarries are worked spasmodically, and in most cases the method of working is of a primitive and wasteful character. A step, however, has been made in the right direction. A recently opened quarry at Ponsonby, near Bathurst, has installed modern machinery, wire-saws, channelling machines, air-drills, etc., and probably others will soon follow.

It is gratifying to see that local marbles are now being extensively used for the decoration of buildings, and as they become better known the demand for them is sure to increase.

A detailed report on these industries is now in course of preparation by the Department of Mines.

Had time permitted I would have liked to refer more fully to the great advances made in the many industries using machinery. The textile trade twenty-five years ago hardly existed, whereas there are now a number of works fitted with up-to-date machinery; the benefit of these works has been shown since the outbreak of the war by their ability to make much of the cloth and the blankets required by the military authorities. The manufacture of paper and cardboard is another industry which has made great progress; in the chemical trade also works have been established. The shale oil industry has not progressed as rapidly as could be desired, although a large amount of capital has been expended on it, much of which is at present bringing in no return, but I trust that the future holds brighter prospects.

Thanks to scientific investigations, aided by practical knowledge, the recovery of metals from the metalliferous ores mined in the State has been so improved, that mines which would not otherwise have been payable, are now successfully carried on.

Shipbuilding, one of the oldest industries of the State, has by the construction of the cruiser "Brisbane" and the destroyers at Cockatoo Dockyard, been rapidly advanced in importance, and the establishment by the State Government of large engineering Works at Newcastle capable of building vessels of considerable dimensions, will I hope, ultimately lead to a greater number of vessels being constructed in the State.

The creation of the Small Arms factory at Lithgow by the Federal Government, is a step towards making us more self contained, and in addition, the training in the use of tools of precision with which the works are equipped, will have its good influence on future workmen.

In coal mining also, the introduction of machinery has had a marked influence on its progress.

It would weary you were I to mention all the industries in the advancement of which the engineer has played a prominent part, but I cannot leave this subject without mentioning the great industry that has arisen as a result of the wise determination of the Government to, as far as possible, have all locomotives required for the State railways manufactured here. In 1905 a contract was let to The Clyde Engineering Co. for sixty locomotives, the average weight being 75 tons, delivery to be made at the rate of ten per year, 750 tons a year, thus requiring six years to complete the contract. The last engine of this contract was finished within five years, together with an additional order for a further fifteen engines, the output for the last year being 1,425 tons. A second contract was then given to the same firm for fifty engines of a heavier class weighing 82 tons each, to be delivered at the rate of two per month, and in 1912 a third contract for 100 engines, each weighing about 83½ tons, thirty-six to be delivered each year. So satisfied were the authorities with the work

turned out, and realising the necessity of fostering such an important business, that the Government, through the Chief Commissioner for Railways, placed with the Clyde Engineering Co. what is probably the largest order ever given for locomotives either here or in any other part of the world, when they last year gave them an order for 300 engines, each weighing about $83\frac{1}{2}$ tons, the contract to be completed in five years, that is at the rate of 5,000 tons per annum.

At the date that the first contract was given, no works in the State were properly equipped with machinery to have enabled it to be satisfactorily completed within the stipulated time, and the Company had to at once expend £15,000 in machinery; since then they have extended their workshops and purchased the most modern plant especially suited for the work, the total outlay during the past six years having amounted to nearly £100,000.

Another works, the proprietors of which have shown their confidence in the continued prosperity of the State, is Mort's Dock and Engineering Co., which realising that Sydney will some day be a greater port than what it is now, have expended large sums in extending the graving dock accommodation of the port. The dock at Balmain, built many years ago, originally had a length of 450 feet; it has been lengthened and is now 640 feet long, and can be divided into two by a middle caisson; the entrance is 69 feet wide at the cope, and 59 feet on the floor, the depth of water over the sill being 18 feet at spring tide. In 1901 they opened a new graving dock at Woolwich on the Parramatta River, which had a length of 500 feet, with a width of 83 feet at the entrance, 75 feet on the floor, and 28 feet of water on the sill at spring tide; this dock has, since its construction, been lengthened from time to time and is now 850 feet long. The company have found it necessary to remodel much of their works to meet modern conditions,

and they have expended large sums on buildings and machinery, notably on the foundry, and they can now cast bronze propellers up to ten tons in weight.

What has been the economic result of this large expenditure that has been incurred? One need only look around the city and evidence of its great prosperity meets one's view everywhere. Whether that prosperity was caused by the increase in the public utilities to which I have referred, or whether the extension and creation of new works was the result of the demand caused by the growing prosperity I cannot say: a consideration of what has resulted will, however, be interesting. In 1891 the population of the State was 1,132,234, at the end of 1916 it had grown to 1,846,736; the population of Sydney has grown at an even greater rate, having increased from 387,434 in 1891 to 764,600 at the end of 1916. Unfortunately the rate of increase in the country towns has not kept pace with the city, with the exception of Newcastle.

Largely owing to the extension of railway lines, the area cultivated for wheat has grown from 333,233 acres in 1891 to 4,235,074 acres in 1915; wheat growing now being one of the important industries of the State.

The railways, which have within the time been nearly doubled in length, and more than doubled in capacity, carried 19,037,760 passengers in 1891, as against 92,850,838 in 1916, and the goods, mineral, and live stock traffic increased proportionately:—

	1891		1916
Coal, coke, and shale, tons	2,673,378	...	6,109,029
Firewood, tons	176,790	...	187,135
Grain and flour, tons ...	198,491	...	852,019
Wool, tons	111,797	...	111,083
Hay, straw, and chaff, tons	64,967	...	429,047
Live stock...	128,211	...	797,065
General merchandise, tons	1,008,599	...	3,128,648
Total	4,362,233	...	11,614,026

Not only has the tonnage grown,but the average distance it is conveyed has grown considerably, coal and coke now being carried an average of 28·57 miles against 17·53 miles in 1891; for grain and flour the average distance has more than doubled, the gross revenue, which in 1891 was £2,974,421 grew to £8,006,078 in 1916, but the net revenue did not unfortunately increase in the same proportion.

The tramways in 1891 carried 62,676,636 passengers; this increased to 292,021,774 by the end of June 1916, due to the extended facilities provided and to the greater prosperity of the people.

Shipping has increased in a similar manner, and the large wharf extension that has been carried out has been no more than what has been necessary to meet the demands made upon it at busy times. The net tonnage of vessels entering the port of Sydney in the year ending June 30th 1914 was 9,437,310, and the number of vessels 10,142; since that date, in consequence of the war, there has been a considerable falling off; in 1902 the tonnage entered was only 4,100,000.

The advance in the supply of gas has been phenomenal, the following figures supplied me by the Australian Gas Light Company show the results as regards Sydney:—

	1891	1916
Coal carbonised, tons ...	125,952 ...	276,154
Coke made, tons	68,595 ...	188,694
Coke used at works ...	28,137 ...	69,223
Tar made, gallons ...	1,373,583 ...	4,173,479
Sulphate of ammonia made, tons	1,323 ...	3,582
Coal gas made in 1000 c.ft.	1,387,858 ...	3,463,452
Water gas...	... ...	1,054,968
Total gas made	1,387,858 ...	4,518,420
Mileage of mains	496 ...	1,468
Number of consumers ...	28,553 ...	135,487

This progress is an indication of what has taken place with the other companies and municipalities supplying the

country towns, those having works under municipal control having in 1914 realised a gross profit after paying management expenses of £19,037 on a loan expenditure of about £122,000, ample to cover interest and depreciation.

The progress of the public supply of electricity has been even greater than that of gas, the following figures supplied by the General Manager of the City Council's works showing :—

	1904		1916
Capital expended	£151,894	...	£2,860,000
Gross revenue	£4,060	...	£434,000
Units of electricity sold per annum	257,499	...	63,593,900
Total load connected equivalent to 60 Watt lamps ...	16,850	...	1,223,000
HP. of motors connected ...	451	...	44,100
Average revenue per unit sold in pence	3·06	...	1·90

The Electric Light and Power Corporation's returns are on a similar, but smaller scale, being :—

	1910		1916
Gross revenue	£5,589	...	£51,000
Units of electricity sold per annum	400,000	...	5,000,000
HP. of motors	506	...	6,000
Total load connected, equivalent to 60 Watt lamps	13,300	...	160,000

The electricity supply works controlled by Councils in country towns made in 1914 an aggregate gross profit of £13,835, the loan expenditure having been about £138,000.

The large expenditure on water supply and sewerage amounting to £16,302,146, for works completed to June 30th, 1916 :—

	Water.		Sewerage.
Sydney	£7,192,472	...	6,114,072
Newcastle	592,880	...	400,351
Country Towns... ...	1,664,058	..	338,313
	9,449,410		6,852,736

is the best investment that the State has made, the reduction in the death rate, and the diminution of sickness throughout the area affected by this expenditure, is a return on which no money value can be placed. The death rate has fallen in Sydney to a half of what it was thirty years ago, having been :—

	Ratio per 1000.	
	Sydney.	Country Districts.
1880 – 1884...	20·60 ...	13·21
1885 – 1889	19·47 ...	12·18
1890 – 1894...	14·83 ...	12·05
1914...	10·26 ...	10·05

It cannot be claimed that this remarkable decrease is due entirely to engineering works; many causes have contributed to it, but without a plentiful supply of water and modern sewage systems, the results could not have been obtained.

The increase in the quantity of water supplied per head per day has been constantly increasing, but has not reached anything like the dimensions that exist in America; no doubt it will grow beyond the 43 gallons which is the present rate for Sydney, in fact in many country towns where inspection is not so rigid, the consumption is much larger.

The consumption per head given above includes water supplied for manufacturing, street watering, and all other purposes besides domestic supply; in the area supplied by the Hunter District Water Board, the proportionate consumption was for 1916 :—

Manufactories	46	per cent.
Street watering and other purposes	2	,,
Charitable institutions	1	,,
Domestic supply	51	,,

Mr. J. H. Cardew, M. Inst. C.E., in 1903 read an interesting paper before our Society on "The Economic Effect of

Sanitary Works," in which he showed that the savings resulting from judiciously constructed works of water supply and sewerage, would in about ten years equal the cost of the works; whether that is so or not, the health and comfort of the people are so largely dependent upon sanitary works, that every endeavour should be made to extend the blessings of a constant supply of good water to every township, and where conditions are in anyway favourable, a sewage system should be constructed.

I have taken up much of your time with an address which is probably too much made up of figures, but without figures I could not express in concrete form, the great advances that have taken place in twenty-five years in this State.

My thanks are due to heads of departments and many others, who have kindly supplied me with data.

NOTES ON ACACIA, No. II.—TROPICAL WESTERN AUSTRALIA.

(INCLUDING DESCRIPTIONS OF NEW SPECIES.)[1]

By J. H. MAIDEN, I.S.O., F.R.S., F.L.S.

[*Read before the Royal Society of N. S. Wales, June 6, 1917.*]

As this paper includes a contribution towards a botanical bibliography of the Nor-West (North West), it is necessary to point out that this short and euphonious title has a technical meaning in Western Australia different to that usually understood in other parts of Australia.

a. The Nor-West of local land administration may be defined as extending from a little south of North West Cape (near Point Cloates) north easterly to, say, Wolla. It lies wholly within the tropics, almost touching the tropic of Capricorn.

b. Jutson[2] defines a North West physiographic division as extending along the coast from the mouth of the DeGrey River (20° approx.) in the north, to the mouth of the Murchison River (28° approx.) in the south. See Fig. 7, p. 32, where it is called the North West Peneplain. See also Fig. 10, p. 38.

On the north-east it is divided from the Kimberley Division by that portion of the Eastern Division known as the Great Sandy Desert. It is a fairly natural division, and I will refer to it on a future occasion when collectively reviewing the botanical provinces of the continent. The length of the present paper precludes this now.

c. I suggest that for present botanical purposes it will be desirable to add to the previous division (*a*), the Kim-

[1] 3 by W. V. Fitzgerald; 3 by J. H. Maiden.

[2] Bulletin No. 61, Geological Survey of W.A. (1914), p. 37.

berley Division (technically termed the Northern Division) and the area joining the two. We thus have the continuous coastal tropical districts of Western Australia as far as their junction with the Northern Territory, into which the western State insensibly merges, and there is no line of botanical separation between them. Indeed, the flora of the Nor-West cannot usefully be studied without taking cognizance of that of the coastal tropical portion of the Northern Territory. When more local floras have been worked out, we shall be able to construct botanical provinces irrespective of the political divisions. In the "Flora Australiensis" and Mueller's "Census," the Nor-West is sunk in the general term of North Australia.

So that we have three different Nor-Wests:—

a. Of local land administration.

b. From the DeGrey to the Murchison.

c. The Nor-West in its wide sense.

Jutson styles the Kimberley Division the Kimberley Peneplain, (*op. cit.*, p. 33) contrasts it with the Eastern Division just to the south, and his remarks are well worthy of reference.

The only list of Western Australian plants known to me is based on Mueller's "Second Census of Australian Plants" (1889); it is *Mueller* and *Morrison's* "List of Extra-tropic West Australian plants" (Vasculares), in the "W. A. Yearbook for 1900-1," by Malcolm A. C. Fraser, Vol. I, p. 308. This list is based on Mueller's compilation for the 1896 Yearbook; Dr. Morrison, then Government Botanist of Western Australia, made a number of additions, and says (p. 308, foot-note):—

"...those recently recorded from within the tropical line have not been excluded from the present list, in spite of the wording of the title; and it is hoped that the next edition will form a complete census of the native plants of the State, including also

many of those tropical species *which have hitherto been recorded as from Northern Australia.*" (The italics are mine.—J.H.M.)

The list was reprinted unaltered in 1903, and not subsequently differentiated, as the late Dr. Morrison hoped. In other words, there is no list of North Western Australian plants published.

Following is a tentative bibliography, arranged in order of date, of the plants of the Nor-West, which will assist in the publication of such a list.

1. *Dampier, William.* He visited Cygnet Bay on the North-west Coast in 1688. He made a second voyage to the west and north-west coast in H.M.S. "Roebuck" in 1699. For some notes on Dampier see my "Records of Western Australian botanists," (Proc. W.A. Nat. Hist. Soc. 1909).

Dampier brought a number of plants back to England, which are the oldest Australian plants known. About a dozen are still in the herbarium of the University of Oxford and figures (and notes) of them by Dr. W. Botting Hemsley, F.R.S., will be found in the "Western Mail," Perth, W.A., Christmas Number, 1898. There is no Acacia amongst them.

2. *Baudin's Expedition*, 1800-4[1] went from Van Diemen's Gulf to Cape Leveque. As a rule, the ships kept far from land, and hence few plants were collected. The natural history results were chiefly zoological; Leschenault de la Tour was botanist. Bentham records that the Expedition collected (1)[2] *A. bivenosa* DC., which appears to be the first Nor-West Acacia collected of which we have any record.

[1] See my paper on the "Earlier French Botanists as regards Australian Plants." This Journ. XLIV, p. 132.

[2] The first of the serial numbers of the Acacias enumerated in this paper.

3. *Cunningham, Allan.* "Narrative of a survey of the intertropical and western Coasts of Australia,...1818 and 1822," by Captain Phillp P. King, R.N., F.R.S., 2 vols. 1827. At vol. II, 497, are "A few general remarks on the vegetation of certain coasts of Terra Australis, and more especially of its north-western shores," by Allan Cunningham. Cunningham's remarks, which are of course valuable, for the most part consist of general sketches of the various families. The collecting places are stated, (they were all coastal) but it would appear that the plants, as a collection, were not described until Bentham undertook that work for the "Flora Australiensis." See p. 76.

4. "*Beagle,*" *(H.M.S.).* During 1838 – 1841, Captains Wickham and Lort Stokes in H.M.S. "Beagle" began and completed an important series of coastal surveys on the North-west coast, discovering the Fitzroy and Adelaide Rivers.

The "Voyage of the Beagle" is quoted for a few specimens in the "Flora Australiensis." Captain Lort Stokes' work, "Discoveries in Australia, with an account of the coasts and rivers explored and surveyed during the voyage of H.M.S. "Beagle," in the years 1837 – 43." (2 vols. 1846), contains but few references to plants the Gouty-stemmed tree, *Adansonia*, (II, 116) being an important exception.

Dr. Benjamin Bynoe, the Surgeon, (see my "Records of W.A. Botanists") made some valuable collections, which went to Kew and were seen by Bentham for the "Flora Australiensis." Bentham sometimes gives the quotation *Bynoe.*

5. *Grey, George.* "Journals of two Expeditions of discovery in North West and Western Australia, during the years 1837, 38 and 39," (2 vols. 1841), contain few incidental references to plants, but the Natural History Appendices

contain no descriptions of them. See my "Records of W.A. Botanists."

6. *Gregory, F. T.* "Expedition to the North West Coast of Australia." (Proc. Roy. Geog. Soc. 1862, p. 372, with a map). At p. 373, "Mr. P. (Pemberton) Walcott joined as a volunteer for the collection of specimens of natural history and botany." There are a few botanical notes at pages 377, 382, 385, 389, 428. The plants collected are recorded in the "Flora Australiensis" as "F. Gregory's Expedition"; Walcott's name was probably not given to Bentham. For a note on Walcott see my "Records of W.A. Botanists."

Bentham records that Maitland Brown also collected specimens in this expedition. See a brief note in the Records just quoted. See also "A record of the plants collected by Mr. Pemberton Walcott and Mr. Maitland Brown in the year 1861, during Mr. Gregory's Exploratory Expedition into North West Australia," by Ferd. Mueller, Trans. Bot. Soc. Edin., vol. II, pp. 479 – 500 (Paper read February 1863).

See "W. A. Year-book, 1900-1," Vol. I. At page 57 is a brief account of F. Gregory's results, and the whole chapter on "Exploration in Western Australia," beginning at p. 50, is valuable. The chapter should be read for a statement of Nor-West explorations.

A useful account of Tropical West Australian explorations will be found at p. 16 of A. Despeissis' "The Nor-West and Tropical North," being Bulletin No. 13 of the Department of Agriculture, W.A. (1911). Mr. Despeissis refers to Mr. F. T. Gregory's report as the "origin and foundation" of Nor-West settlement, so that special attention to the district has only taken place within the last half-century, and its comparative inaccessibility, and the moisture-laden atmosphere of a portion of it, both explain the delay which has occurred in working out the plants.

7. *Tenison-Woods, Julian E.* "North Australia; its physical geography and natural history," 8vo. pp. 46, Govt. Printer, Adelaide, 1864. Chapter viii, p. 38, Botany, gives a very condensed summary, chiefly of Mueller's then recent Northern Territory results. (A. C. Gregory's expedition of 1856). Father Tenison-Woods' account of geographical explorations to date, includes those of tropical Western Australia, and has been well done.

8. *Bentham, George.* "Flora Australiensis," Vol. II, (1864). This is the work which contains by far the most important account of Nor-West Acacias to date, and of course other plants.

A. BOSSIÆOIDES A. Cunn.

In Cunningham's MS. Journal, Vol. II, p. 60, under date 6th August, 1819, he says, "Liverpool River, North Coast. I gathered specimens, although without flower or fruit of an Acacia (evidently) having the habit of a flat-stemmed *Bossiœa*." He then gave a description in Latin.

Bentham (B.Fl. ii, 320) "gives Liverpool River, North-west Coast"; it is, however, in the Northern Territory, and B. Gulliver, one of Mueller's correspondents, collected it in the same place. It remains to be proved that it is a Nor-West plant.

Seemann, in "Die in Europa eingeführten Acacien" (Hanover, 1852), has a figure of "*A. bossiœoides*" in flower drawn by J. D. Hooker, but it is *A. glaucoptera* Benth.

2.[1] A. PATENS F.v.M.

Stony places, Hammersley Range, Nichol Bay. F. Gregory's Expedition.

3. A. BYNOEANA Benth.

N.W. Coast, *Bynoe*. See a note by myself in this Journal, XLIX, p. 501 (1915). See a note on petals and pod by W. V. Fitzgerald in Journ. W.A. Nat. Hist. Soc., May, 1904, p. 46.

[1] The second of the serial numbers of the Acacias enumerated in this paper. Henceforward the numbers can be readily picked up.

4. A. LYCOPODIFOLIA A. Cunn.

Cambridge Gulf, N. W. Coast, A. Cunningham; Hammersley Range, Nichol Bay, F. Gregory's Expedition. Cunningham's MS. Journal, Vol. II, p. 75, shows that he collected it on 19th September, 1819. He speaks of it as "a rare shrub of divaricate growth" and gives a Latin description of it.

[Mr. W. V. Fitzgerald thus describes a specimen collected in the Nor-West. "Diffuse, to 3 feet high, and often as much across; phyllodia frequently in whorls of 12, the tips glabrous, usually viscid, otherwise the whole plant slightly to densely hoary with spreading white hairs; corolla lobes short, with incurved callous tips; pod viscid; seeds transverse, shining-black." MSS.]

5. A. HIPPUROIDES Heward.

Usborne's Harbour, N.W. Coast, "Voyage of the Beagle."

See also a note "Diffuse, to 4 feet high; phyllodia with yellow setaceous glabrous viscid points which are often as long as the balance of the phyllodia; flower-heads larger than those of *A. lycopodifolia;* calyx at least two-thirds the length of the corolla, the lobes short and broad; corolla lobed to above the middle, the lobes with callous incurved tips; pod viscid, flattened, straight or slightly falcate, to two and a-half inches long by three lines broad; seeds black, shining, oblique." (W. V. Fitzgerald MSS.).

6. A. GREGORII F.v.M.

Nickol Bay, N.W. Coast, F. Gregory's Expedition.

7. A. SPATHULATA F.v.M.

Bay of Rest, N.W. Coast, A. Cunningham.

8. A. PYRIFOLIA DC.

Dampier's Archipelago, A. Cunningham. Nickol Bay, F. Gregory's Expedition.

9. A. DELTOIDEA A. Cunn.

Greville Island, Montague Sound and Barren Islands, Regent's Inlet, N.W. Coast, A. Cunningham.

10. A. SETULIFERA Benth.

N.W. Coast, Bynoe.

11. A. TRANSLUCENS A. Cunn.

Montague Island and Bay of Rest, N.W. Coast, A. Cunningham. "Diffuse, one to two feet high or erect and four to six feet; calyx much less than half the length of the corolla; pod sometimes two inches long by one-third inch broad; seeds greyish, with a white arillus." (W. V. Fitzgerald MSS.).

A. translucens was described and figured in Hooker's "Icones," tab. CLX. The type comes from the North West Coast, and it appears to be the common form there. Bentham observed a form with narrow (curved linear) phyllodes, and it would appear to be commonest in the Northern Territory (Gulf of Carpentaria). From the quartzite ranges on the west side of Blunder Bay, Victoria River, 1913 (R. T. Winters, comm. E. J. Dunn and G. F. Hill) I have received a form with phyllodes much larger than the type.

1. A. BIVENOSA DC.

N.W. Coast, Admiralty Bay, Baudin's Expedition; Bay of Rest and Dampier's Archipelago, A. Cunningham. Depuech Island, Bynoe; Hearson Island, Nickol Bay, F. Gregory's Expedition.

"Erect shrub, 5–8 feet; to a tree of 15–30 feet; trunk to 10 feet; diam. to 1 foot; foliage glaucous; bark dark grey, somewhat rough; timber brownish, rather hard and tough." (W. V. Fitzgerald. MSS.).

12. A. CORIACEA DC.

Bay of Rest, N.W. Coast, A. Cunningham; Depuech Island, Bynoe; Nickol Bay, F. Gregory's Expedition.

13. A. HEMIGNOSTA F.v.M.

Cambridge Gulf, A. Cunningham.

"Tree of 25 – 30 feet; trunk to 10 feet, diam. 1 foot; bark dark-coloured, rough, longitudinally fissured and often corky; timber brownish, hard and tough." (W. V. Fitzgerald MSS.). As regards North Queensland trees, see R. H. Cambage, this Journal, XLIX, 389 (1915).

14. A. SERICATA A. Cunn.

Montagu and York Sounds, N.W. Coast, A. Cunningham.

"A tall glaucous shrub to a tree of 30 feet; trunk to 10 feet; diam. 9 inches; bark dark-grey, somewhat rough; timber pale and tough; flowers pale-yellow, through leaf-suppression terminally racemose; peduncles 2 – 3 together, mostly ½ in. long, each bearing a globular head of 20 – 30 mostly five-merous flowers; sepals free nearly to the base, broadly spathulate, half as long as the petals, finely hirsute; petals free nearly to the base, slightly silky." (W. V. Fitzgerald, MSS.).

15. A. WICKHAMI Benth.

Swan Bay, N.W. Coast, Voyage of the Beagle.

"Sunday Island; May, Lennard and Calder Rivers; Mounts House, Clifton and Brennan. Rigid, diffuse, 3 – 4 feet high, and often as much across. Among sandstone and quartzite rocks." (W. V. Fitzgerald, MSS.).

16. A. STIGMATOPHYLLA A. Cunn.

Brunswick Bay, N.W. Coast, A. Cunningham.

"Lennard and Isdell Rivers. A spreading shrub of 5 – 8 feet high to a tree of 15 – 20 feet; trunk to 5 feet; diam. 6 in.; bark roughish, reddish-grey, sometimes curly; timber dark brown, and moderately hard; the branchlets and phyllodia slightly viscid; pod erect, linear, slightly falcate, 2 – 3 in. long, 3 lines broad, compressed but thick with obliquely transverse septæ between the seeds; valves rolling

back from the apex on dehiscence, hard, the margins raised and obliquely veined between; seeds obliquely oblong, dark brown; funicle straight or slightly folded, gradually thickened upwards and terminating in a cupular, pale-coloured basilar arillus." (W. V. Fitzgerald MSS.).

17. A. XYLOCARPA A. Cunn.

Dampier's Archipelago and Water Island, N.W. Coast, A. Cunningham. Nickol Bay, F. Gregory's Expedition.

Cunningham (MS. Journal, Vol. II, p. 72), collected it at Lacrosse Island on 17th September, 1819, and says, "A depressed bushy plant, and remarkable for the clear stark verdure of the whole shrub; is also abundant among the rocks, having old pods which are woody and cylindrical." He gives a Latin description.

"Varies from a diffuse shrub of 3 feet to a tree of 30 feet; trunk to 10 feet, diam. 8 in.; bark grey, somewhat rough; timber dark brown, and very hard. In sandy soil among sandstone and quartzite rocks." (W. V. Fitzgerald MSS.)

"Var. *planifolia* W. V. F., var. nov. Artesian Range. A diffuse shrub, 3–4 feet high, the young shoots viscid; phyllodia compressed, elliptical to linear-oblanceolate, straight or falcate, 1½ to 2½ in. long; pod as in type. In sandy soil." (W. V. Fitzgerald MSS.).

18. A. ARIDA Benth.

Parched desert shores of Cambridge Gulf, N.W. Coast. A. Cunningham.

19. A. DELIBRATA A. Cunn.

So much uncertainty surrounds *A. delibrata* and so much depends on it, that it becomes desirable to examine the evidence.

Cunningham's original description in Benth., Lond. Journ. Bot. I, 374 (1842) may be translated as follows:—

Glabrous, viscid, branchlets angular and finally terete, phyllodes narrowly falcate-lanceolate or linear, narrowed on both sides,

somewhat obtuse at the apex, obliquely mucronate, immarginate, finely striate, many nerved, spikes shortly pedunculate, pod linear, smooth, coriaceous, glabrous, uniform within. Phyllodes 4 – 5 ins., almost like *A. julifera* but less pointed. Flowers not seen. Pod 4 – 5 ins. long, almost 4 lines broad, margin thickened, slightly contracted between the seeds.[1]

The type came from York Sound and Port Warrender (North West Australia) Cunningham. The bark of the older branches appears to peel off in small shreds, whence Cunningham's name (*delibratus*, Latin, having the bark peeled off).

Then Mueller in Journn. Linn. Soc., III, 138, (1859) re-described the species in terms that may be translated as follows:—

Arborescent, branchlets angular, glutinous, glabrous or velvet-like, phyllodes somewhat sessile, linear-falcate or sword-shaped or more rarely shortened, narrow-oblong, obliquely acuminate or cuspidate-apiculate, prominently 1 – 3 nerved, glabrous or rarely puberulous, densely parallel-veined, bearing a gland right at the base, spikes short, solitary or two in the axils, dense, shortly pedunculate, the corolla with five-divisions, being half as large again as the dentate-ciliate calyx,[2] pod stipitate, papery, narrow, oblong, compressed, marginate, pale yellow, with undulate margin, seeds shining-black, compressed-ovate, three times as long as the white cymbiform arillus, (strophiole), distinctly marked on both sides.

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[1] Bentham recognised that these specimens were not altogether satisfactory, for in a note in Journ. Linn. Soc. III, 139, referring to *A. delibrata*, he says "Cunningham's (specimens) are out of flower with a loose fruit; but, as far as these materials admit of identification,"...Fortunately the phyllodes and pod are, with our later knowledge, quite sufficient to say what the species is.

In the fuller description by Bentham of *A. delibrata* in B. Fl. II, 405, he supplements the original description as regards the tomentum, saying "Branchlets...silky-pubescent when young. Phyllodia...sprinkled with loose silky hairs." This hairiness is important.

[2] This does not agree with his figure of *A. delibrata* in "Iconography."

A shrub, six to twelve feet high. Phyllodes six inches long or shorter, seldom only an inch and a half long, $1\frac{1}{2}-3$ lines broad. Spikes 1 in. long or shorter, pods 1 – 3 inches long, about 4 lines broad, shining, not undulate at the sutures. Seeds a line and a half long, arillus ("strophiole") with one fold.

It will be observed that flowers were not available when the type was described, while the specimens available to Mueller were from the Northern Territory and Queensland, and his description has been drawn up from mixed material.

The localities quoted by Mueller are "Arnhem's Land, No. 28; Head of Seven Emu River, No. 40; Upper Roper, No. 25;[1] Moreton Bay, Moore; Fitzmaurice River, No. 91; Sturt's Creek, No. 92; Victoria River, No. 93."[1] Some of these numbers are referred to by Bentham in his footnote to *A. oligoneura* (see p. 110). Mueller's specimens do not appear to be in Australia, at all events under their numbers, while the specimen "Moreton Bay," which often meant Queensland, is not available.

When Bentham re-described the species in English in B. Fl. II, 404, he ignored Mueller's description of the flowers, presumably because he had some doubt about the matching. I do not know of any evidence that Mueller ever saw *A. delibrata*.

At length *A. delibrata* has been rediscovered. Mr. Fitzgerald collected it in North West Australia and wrote out a description of it as a new species. I gave this the most careful scrutiny and concurred, when the portion of the type of *A. delibrata* arrived from Kew, and it was at once seen that here we had the long lost species. Mr. Fitzgerald's description, which follows, is valuable as an up to date account of *A. delibrata*, including the flowers, which neither Cunningham nor Bentham saw. Some of

[1] Nos. 25 and 93 are not *A. delibrata* at all, but *A. Hammondi* n. sp., see p. 95.

Mr. Fitzgerald's phyllodes are a little narrower than those of the type.

A tree, the branchlets terete, or scarcely angular and along with the foliage and rhachises finely pubescent and slightly viscid; phyllodia linear to linear-lanceolate, straight or slightly falcate, narrowed at both ends and terminating in obtuse or acute curved or straight points, thinly coriaceous, striate with numerous fine parallel nerves, the central one always and usually two lateral ones very evident; spikes solitary or two together, very slender, not dense, pedunculate; flowers small, mostly pentamerous; calyx membranous, silky-pubescent, divided to below the middle, more than half as long as the corolla, the lobes comparatively broad; petals obtuse, not ribbed or striate, connate to the middle, glabrous or scantily pubescent; pod linear, much attenuated and stipes-like at the base, resinous, hard and of a woody texture, the valves with prominent raised longitudinal angles on each side of the sutures, and contracted laterally between the seeds; seeds longitudinal, ovate, dark brown; funicle with few folds and gradually thickened into a pale-coloured turbinate basilar arillus.

Isdell River; eastern base of Mount Rason; Sunday Island (W.V.F.). In stony spots overlying sandstone and quartzite.

Height 25 – 40 feet; trunk to 15 feet; diam. 9 – 12 inches. Bark reddish, rough and curly. Timber dark brown, hard, rather heavy and tough. Phyllodia 2 – 6 inches long, 2 – 4 inches broad. Spikes 1 inch or less. Pod 3 – 4 inches long, $\frac{1}{4}$ inch broad.

Affinity to *A. delibrata* A. Cunn. (End of Mr. Fitzgerald's description).

Following are my notes:—Flowers pentamerous, in spikes, recurving as they get old. Calyx irregularly lobed, a few hairs at the apex, very thin and frail. Petals glabrous, divided partly down. Ovarium hoary.

Affinities.

1. With *A. gonocarpa* F.v.M. The pods of *A. gonocarpa* are six-angled, woody, obliquely divided inside; the seed

long and narrow, suspended by a conoid funicle-arillus. In *A. delibrata* there are two folds in the funicle and it and the arillus are not conoid.

2. With *A. Kimberleyensis* n. sp. A narrow phylloded form of *A. delibrata* is strikingly similar in general appearance to *A. Kimberleyensis.*

The stems of *A. delibrata* are terete nearly the whole way up, and are covered with fine silky hair when young. The phyllodes of *A. delibrata* are generally shorter and broader, more finely striate and clothed in fine white silky hair, especially when young. They have one gland at the base; tips sharply acuminate but not rigid. The phyllodes thin. The calyx is deeply and irregularly lobed sometimes half way down, or nearly to the base; tips hairy. The pod is six-sided, viscid. The seed a short oblong. The funicle twisted, small arillus, while the funicle and arillus of *A. Kimberleyensis* together form a conoid mass.

A. Armitii F.v.M. (ined.)

(Syn. *A. delibrata* F.v.M., "Iconography of Acacias" non A. Cunn.).

"Shrubby, branchlets glabrous, prominently angular; phyllodes almost straight, narrow-lanceolar, elongated, sessile, blunt or slightly acute at the upper end, without any lustre; their primary venules usually three, the middle one the strongest, secondary venules numerous, all straight and closely approximated; glandule anteriorly basal; spikes axillary, solitary, short-stalked, considerably surpassed in length by the phyllodes; rhachis closely invested with very short spreading hairlets; sepals narrow, disconnected, fully half as long as the corolla, or even longer, as well as the latter beset with a very short somewhat viscid vestiture; tube of the corolla about as long as the semilanceolar-deltoid lobes; fruits broad-linear, much compressed, somewhat flexuous, quite viscid, prominently margined; ovules ellipsoid, on a straight gradually upwards thickened funicle.

"Near the Ennasleigh River. W. Armit."

"Differs from *A. conspersa* already in compressed-angular glabrous branchlets, in obliterated stipules, more than one primary venule of the phyllodes, in very sticky less turgid fruits and in untwisted funicles; from *A. gonoclada* in usually narrower phyllodes, longer spikes, less crowded flowers, more velvet-like vestiture of the rhachis, and unconnate sepals. From both it may further differ in carpologic characteristics, but the ripe fruit remained hitherto unknown." (Mueller, MSS. in Herb. Melb.).

After writing the description, Mueller refused to publish it, marking it "*A. delibrata* aff." A sight of the type shows that *A. delibrata* is a very different plant, and I take the responsibility of reversing Mueller's decision, and publishing his description. Its affinity is to *A. plectocarpa*, and while I admit the material is incomplete, it seems to me that it is in the interests of science to give this figured form a name under the circumstances.

Named in honour of W. E. Armit. Biographical notes on Mr. Armit will be found in Proc. Aust. Assoc. Adv. Science, xii, 374, (1909). Mr. Banfield of Dunk Island, North Queensland, kindly tells me that his name was William Edington Armit. He died in Papua. His son, Mr. L. P. B. Armit is an official of that dependency.

Range. North Queensland only, so far as we know at present.

Armit's label says "Ennasleigh," Sands' Queensland Map of 1886 (New Atlas of Australia) "Einasleigh," and Whitworth's Bailière's "Queensland Gazetteer" (1876) has "Einsleigh." Mr. Allan A. Spowers, Surveyor General of Queensland, says the official spelling is Einasleigh. He says that Frank Jardine named it in remembrance of a lady, Annie, transposing the first two syllables.

"It is a large shallow river, from three quarters to a mile wide, flowing about forty miles east of Georgetown in

to the Gilbert River in about 17° 30′ S. Lat. It rises in the Ironbark ridges to the east of Gilberton, and flows N. and W. through the pastoral and mineral country of the Carpentaria downs. It is fed by the Copperfield, Stockman, Elizabeth, Lagoon, Lee, and other small creeks. Granite and porphyry." (Whitworth, corrected by Mr. Spowers).

I give these particulars in the hope that better specimens may be further searched for in this locality. Twigs bearing ripe pods are particularly desired.

The interesting point about the specimens described is that they prove to be the specimens figured by Mueller in his Iconography as *A. delibrata*, and it throws light on Mueller's view of that, (a very different) species in his later years. Had Mueller stated the locality of the specimens depicted in the Iconography, he would have saved users of the work much trouble as regards some of the plates.

The Einasleigh specimens consist of a few twigs in early fruit, with a few flowers almost in the last stage. Unfortunately Mueller's plate is, in some respects, unreliable. The pods shown on the right hand twig are broader than in the original, and are shaded to give the idea of maturity. These pods, more than any other part of the plate, have caused trouble. The original specimens are so immature that one cannot be certain that the seeds will be oblique at maturity, but the figure of the pods on the twig not only leads one to assume that they are ripe, but figure 7 certainly shows them so. There is no warrant for showing the funicle and arillus as at 7. Ripe seeds are shown at figures 8 etc., but they are the result of pictorial license. The flowering specimen at the left of the plate cannot be found.

Fragments of flowers are persistent on the rhachis until the young pods are as much as two inches long. This is shown in the Einasleigh specimens and also in the Iconography plate.

Affinities.

1. With *A. plectocarpa* A. Cunn. *A. Armitii* appears to be a more rigid plant than *A. plectocarpa*. The flowers of *A. Armitii* have slenderer sepals and a more hairy corolla; it is a matter of surmise whether the unripe pods of *A. Armitii* will develop into a pod identical with that of typical *plectocarpa*, which becomes markedly embossed when fully ripe. The markedly resinous character in the young pods of *A. Armitii* is noticeable, and the only young pods of *A. plectocarpa* I have seen are resinous. The seed of *A. Armitii* as figured is ovoid; that of *A. plectocarpa* is nearly round, with an almost circular depression.

2. With *A. Hemsleyi* Maiden. The flowers of the two species possess a very close resemblance; the rhachis of *A. Hemsleyi* is smoother. The pods of the two species are, however, very different, those of *A. Hemsleyi* being narrow, and having elongated seeds longitudinally arranged.

A. Hemsleyi n. sp.

Julifloræ (Falcatæ)

Frutex altus fere glabrus vel arbor parva, ramulis junioribus angulatis. Phyllodiis lineari-lanceolatis, paullo falcatis, basin versus angustatis, 9 – 12 cm. longis, 10 – 13 mm. latis, tenuibus, 3 – 5 nervis prominentibus. Spicis solitariis vel geminis axillaribus, tenuibus ad 4 cm. longis pedunculis 1 cm. vel longioribus. Floribus dense confertis, calyce profunde lobato. Sepalis angustis ca. dimidio corolla æquilongis, ciliatis. Petalis secundum lineam mediam ciliatis, dimidio longitudinis connatis. Pistillo hirsuto. Legumine lineari, 7 – 11 cm. longo, 5 mm. lato, gracile. Valvis tenuibus, marginibus incrassatis, planatiusculis, paullo moniliformibus, seminibus longitudinaliter dispositis. Funiculo tenue in arillum basilarem terminante.

A tall shrub or small tree, nearly glabrous, with branchlets angular when young, but soon becoming terete.

Phyllodia linear-lanceolate, slightly falcate, with an oblique sharp but not rigid point, the upper part of the phyllode often dark coloured. Narrowed towards the base, 9 – 12 cm. ($3\frac{1}{2}$ – $4\frac{3}{4}$ inches) long, 10 – 13 mm. broad, thin, with 3 to 5 prominent nerves, and numerous very fine parallel ones between them. An elongated gland at the base. Stipules acute, brown, scarious.

Spikes solitary or in pairs in the axils, thin, up to 4 cm. long on peduncles up to 1 cm. and more, flowers 5-merous, closely packed on the spike. Floral bracts foliaceous and ciliate. Calyx deeply lobed, the sepals narrow, about half as long as the corolla, ciliate. Petals ciliate down the median line, united to about the middle. Pistil hairy.

Pod linear, 7 – 11 cm. (or say $2\frac{1}{2}$ – $4\frac{1}{2}$ inches) long, 5 mm. broad, slender and with thin valves, with thickened margins, flattish, slightly moniliform, seeds longitudinally arranged, black, shining, with a thin funicle which soon becomes a ribbon-like mass, in two or more folds, and passes into a small basilar arillus.

In honour of Dr. William Botting Hemsley, F.R.S., late of Kew, who for many years helped Bentham in the elucidation of this genus, and indeed the Australian flora generally, for the "Flora Australiensis," I dedicate this beautiful and interesting species.

Range. A tropical species, extending from North West Australia (Kimberley district) through the northern portions of the Northern Territory, to Northern Queensland (at no great distance from the Gulf of Carpentaria).

The following specimens have been examined by me:—

1. Fitzroy River, 8 miles above Hann River junction. June, 1905. In flower. (W. V. Fitzgerald, No. 1177; this I constitute the type.

2. Isdell River, 10 miles below Grace Knob, July, 1905. In flower (W. V. Fitzgerald, No. 1235; received as *A. torulosa* Benth.).

3. Barker River, Kimberley, W. A., September, 1905. In fruit (W. V. Fitzgerald, No. 1535; received as *A. torulosa* Benth.).

4. In flower, April, 1916. Wandi, Northern Territory (Dr. H. I. Jensen, No. 395). Not quite normal.

5. "Queensland Gulf Country." In fruit. (Dr. T. L. Bancroft). Dr. Bancroft recently informed me that the locality is a scrub on the Gregory Downs, Gregory River, near Burketown. Labelled by the late F. M. Bailey, "Nearly allied to *A. delibrata*." He sent precisely similar specimens to Mueller, with the following result. He wrote to Mueller, "Seed of Acacia near *A. delibrata* A. Cunn., Gulf Country, Queensland. From this shrub Dr. Thomas L. Bancroft has obtained if not a valuable still a curious property, an account of which is being prepared by the doctor.[1] The specimen somewhat agrees with Bentham's description of *A. delibrata* A. Cunn., of which I have never seen specimens."

Mueller endorsed these specimens (bark, phyllodes, ripe pods and an old flower), "Acacia allied to *A. sp.* (from Einasleigh). The bark seems not to peel off in shreds. Bentham (in Hook. Journ.) calls the legumes nearly four lines broad. Stipules present as in *A. conspersa;* funicle different from that species, so absence of toment on the branchlets and absence of strong midnerve."

6. Dugald River, Granada, on bank of river, 10 feet high. 50 miles north of Cloncurry, Northern Queensland. 30th August, 1913. In early fruit and just past flowering. (R. H. Cambage, No. 4165).

[1] Dr. T. L. Bancroft found saponin in the pods, being led to enquire into their disagreeable, acrid taste. Proc. Roy. Soc. Qld., IV, 10, (1887).

Affinities.

1. With *A. delibrata* A. Cunn. Both Bailey and Mueller remark on the affinity of this species to *A. delibrata*, though Mueller did not endorse the resemblance. As we now know what *A. delibrata* is, we are in a position to make a comparison denied to these two botanists.

The phyllodes of the two species are sharply different, those of *A. delibrata* being much narrower, less numerously veined, and with a fine silky tomentum. The flowers are different, though not markedly so, but the pods are different, those of *A. Hemsleyi* being longer and narrower, less moniliform, and with thicker longitudinal angles at the sutures.

2. With *A. torulosa* F.v.M. It would appear that *A. Hemsleyi* is closely allied to this species, but it is sharply separated from *A. torulosa* by the strongly moniliform pods of the latter (the seeds also are different), and less emphatically by the more spathulate sepals and more coriaceous and longer phyllodes of the same species.

3. With *A. plectocarpa* A. Cunn. In flowers and phyllodes *A. Hemsleyi* closely resembles *A. plectocarpa*, but it is quite distinct in the pod.

4. With *A. julifera* Benth. This species has usually a more falcate phyllode, and it is sharply separated from *A. Hemsleyi* by its elongated, narrow, spirally twisted pod.

5. With *A. leptocarpa* A. Cunn. The two species are much alike in the shape and venation of the phyllodes, but they are quite different in the attachment; those of *A. Hemsleyi* are almost sessile.

20. A. PLECTOCARPA A. Cunn.

It is described from Cunningham's MSS. by Bentham in London Journ. of Bot., I, 375 (1842), in words which may be translated as follows:—

"Glabrous, subglaucescent, branchlets angular, subtriquetrous, phyllodes falcate-lanceolate, base and apex tapering, finely striate, many nerved, spikes elongated-cylindrical, interrupted, calyx sinuate-dentate, three or four times shorter than the corolla,[1] pod straight, linear, smooth, marginate, coriaceous, glabrous, valves more often bullate-flexuose. Phyllodes and flowers of *A. leptocarpa.*[2] Spikes longer, rather interrupted. Pod 3—4 lines broad. Cambridge Gulf and Sims's Island, N.E. Coast. Cunningham."

(Cambridge Gulf is N.W. Coast, and Sims's Island is near the Goulburn Islands, Northern Territory).

It is not referred to by Mueller in his paper on Northern Territory Acacias in Journ. Linn. Soc., III, 114 (1859), but Bentham, in B. Fl. II, 408, in quoting some specimens collected by Mueller, obviously refers to those collected at the same time as those described in the Linnean Society paper, although numbers are not quoted. Of course, all of the specimens examined by Bentham may not be typical.

Bentham redescribed the species in B. Fl., II, 408, and what he says has enhanced value, because he edited Cunningham's original description. He says "Calyx short, minutely toothed. Petals smooth." Of *A. leptocarpa* he says, (*op. cit.*, 407), "calyx short, sinuate-toothed. Petals smooth, united at the base," making no reference to the calyx of either species being "three or four times shorter than the corolla."

Sir David Prain has had the kindness to present to the National Herbarium, Sydney, portions of the co-types, viz.,

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[1] This seems to be overstated, as it appears to be always half the length (and therefore twice shorter) of the corolla. See below, p. 92.

[2] At p. 376, Bentham describes those of *A. leptocarpa* as "Phyllodes... 4–6 inches long, 4–5 lines broad, very much bowed, narrowed into rather a long petiole. Spikes 1–1½ inches long, flowers distinct." In *A. leptocarpa* the spikes are "somewhat interrupted," and the calyx "many times shorter than the corolla."

phyllodes and portion of a valve of the Cambridge Gulf specimen, and phyllodes, a pod and two seeds of the Sims's Island specimen.

The original speaks of the phyllodes as "finely striate and many nerved." Bentham (B. Fl.) speaks of them as with "about three nerves." The phyllodes of *A. plectocarpa* in the "Iconography" are smaller, and have uniformly two nerves. They are, in my opinion, a different species; see p. 96.

Mr. Fitzgerald collected specimens and considered them to belong to a new species. His description follows, and is worthy of publication although his plant is, in my view, conspecific with *A. plectocarpa.*

Mr. Fitzgerald's description begins here:—

A tall shrub to a tree; branchlets angular and along with the phyllodia and rhachises viscid, otherwise glabrous or nearly so; phyllodia lanceolate to narrow-lanceolate, slightly falcate, terminating in a short oblique point, attenuated at the base, of thin texture, with three conspicuous longitudinal nerves and numerous finer ones closely packed between and slightly anastomosing; spikes slender, dense, two together or the uppermost three together, and forming a terminal leafy panicle; flowers small, 4-5-6- merous, the calyx and often the corolla and rhachis closely invested with a short golden-coloured pubescence; calyx lobed almost to the base, the sepals linear, half as long as the corolla; petals broad, connate to above the middle, not ribbed or striate; pod straight, linear,[1] viscid, compressed, the sutures narrow; valves thinly coriaceous, very much undulate; seeds oblique, almost orbicular, dark brown; funicle filiform and straight to near the base of the seed where it forms several dilated folds which constitute an irregular cupular pale coloured basilar arillus.

Lennard, Isdell, Hann, Fitzroy and Charnley Rivers, (W.V.F.)

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[1] The word linear is misleading, in view of the further statement that the pod of 4 – 5 inches long is one-third inch broad. Such an expression as "moderately broad" would be better.—J.H.M.

Among sandstone and quartzite rocks and gravel.

Height 25 – 30 feet; trunk to 10 feet; diam. 9 inches. Bark roughish, dark grey. Timber brown, moderately hard and heavy, tough. Phyllodia 3 – 6 inches long, 5 – 7 lines broad. Spikes $1\frac{1}{2}$ to above $2\frac{1}{2}$ inches long. Pod usually 4 – 5 inches long, by one-third inch broad.

Affinities to *A. plectocarpa* A. Cunn., and *A. pachycarpa* F.v.M. (end of Mr. Fitzgerald's words).

Range. We only know this species from North Western Australia at present, with the single exception of the Sims's Island (Northern Territory) specimen. All Mr. Fitzgerald's specimens are from West Kimberley, roughly about 16° 30′ south latitude, and between the western boundary of the Kimberley Gold-field and Collier Bay.

The following five specimens, all either in flower or early fruit, correspond to Mr. Fitzgerald's description, already given:—

1. Isdell River, near Mount Barnett, West Kimberley, June, 1905 (Type). In flower and early (viscid) fruit. (W. V.F. No. 1015),

2. Base of Mount Rason. In half-grown fruit, viscid. (W.V.F. No. 1293).

3. Six miles north east of Mount Eliza. In flower (W. V.F. No. 743).

4. Pandanus Creek. In flower (W.V.F. No. 1067).

5. Charnley River near F.B. (Camp F. Brockman) 33. In early viscid fruit. (W.V.F. No. 1397).

Mr. Fitzgerald's statement that his new species has affinity with *A. plectocarpa* A. Cunn. and *A. pachycarpa* F.v.M. is explained by the following specimens in fully matured fruit, which, in my opinion, are all *A. plectocarpa.*

1. In ripe fruit. "Erect, 10 feet high." Cambridge Gulf, North of Wyndham; East Kimberley (W.V.F. No.

1589, and labelled by him *A. plectocarpa* A. Cunn. Mr. Fitzgerald "builded better than he knew."

2. Wyndham, in ripe fruit (A. E.V. Woodroffe, September, 1903).

3. Shrub 20 feet high; in ripe fruit. Denham River, East Kimberley. (W.V.F. without number, and labelled by him *A. plectocarpa*).

The seeds of all three specimens are nearly globular, and the almost thread like funicle has two folds, and terminates in a scarcely enlarged basilar arillus.

Specimen No. 3 contains a portion of a flower-spike. The flowers are so resinous that it is difficult to dissect them. The calyx is nearly divided to the base, and the sepals are narrow and tipped with hairs.

Affinities.

1. With *A. Hammondi* n. sp. See p. 95.

2. With *A. pachycarpa* F.v.M., a species that is imperfectly known, but I have certain direct evidence in regard to it. A translation of the original description (Journ. Linn. Soc., III, 139, 1859) is as follows :—

Glabrous, branches angular on the upper side, phyllodes very shortly petiolate, lanceolate or elongate-linear, more or less falcate, recurved-apiculate, inclined to be three-nerved, with numerous very fine parallel veins, having a gland at the base, spikes in short terminal axils, solitary or two, dense and rather shortly pedunculate, calyx five-sinuate, glabrous, three times shorter than the corolla, pod pale yellow, thick, elongated-oblong, flexuose, indehiscent, torulose, marginate, obtuse at the apex, acute at the base, almost straight at the sutures, seeds ovate-globose, opaque, dark, somewhat compressed, with minute whitish strophioles.

At the bank of Sturt's Creek, sub-central Australia, No. 89.

A tall tree, unless I am mistaken. Phyllodes 2 inches or almost a foot long, about 3‴ broad. Corollas small. Pods $1\frac{1}{2}$ – $2\frac{1}{2}$″ long,

almost ½ inch broad. Seeds about 2‴ long, one side very often convex, the other more flattened. The species resembles *Acacias drepanocarpa*, *julifera*, and *delibrata*, in its phyllodes, in the pod however, it is very different. (Description ends here).

The limits of length given for the phyllodes are remarkable, and point to mixed material. They are up to a foot long, and are not near to those of *A. plectocarpa*, but rather resemble those of *A. coriacea* and *stenophylla*, members of the Plurinerves (Microneura). The specimen in fruit in the plate of *A. pachycarpa* in the "Iconography of Acacias" is typical, and the differences between these phyllodes and those of *plectocarpa* are at once observable. The flowering twig of *A. pachycarpa* depicted has certainly different phyllodes, and perhaps it may not be correct. Coming to the fruits, Bentham says those of *A. plectocarpa* may be "almost as broad and thick as in *A. pachycarpa*."

It is desirable that *A. pachycarpa* be re-collected, before we can fully indicate its affinities.

A. Hammondi n. sp.

(Julifloræ—Falcatæ.)

(*A. plectocarpa* F.v.M. of the "Iconography of Australian Acacias" non A. Cunn.)

In addition to the type specimens of *A. plectocarpa*, Sir David Prain had the goodness to give me fragments of *A. plectocarpa* A. Cunn., written up by Bentham as var." as follows:—

a. Roper, *Mueller*, No. 25. Phyllodes and pods.

b. Lower Victoria River, *Mueller*, No. 93. Phyllodes and flowers. Both are Northern Territory localities.

Reference to Journ. Linn. Soc., III, 138, shows that Mueller himself referred them to *A. delibrata* A. Cunn., which is additional evidence that he had either never seen or had forgotten *A. delibrata*.

The phyllodes are much shorter and narrower than typical *plectocarpa* and have only *two* nerves. It is obvious that (*a*) and (*b*) were used by Mueller for the purpose of figuring *A. plectocarpa* in the "Iconography," as regards details in addition to the phyllodes.

The pods have a translucent or waxy lustre, and specimens closely approaching (*a*) and (*b*), though with some slight variation in the venation, are available from Etheridge River, North Queensland (W. E. Armit, No. 624), and shrub of 8 – 10 feet, Cloncurry Road, Normanton, Gulf of Carpentaria (R. H. Cambage, No. 3935).

No. 3935 has scanty remains of flowers which appear to be identical with those of No. 93, about to be described.

We have, in my view, a new species, and it may be described as follows:—

Frutex glabrus præter paucos pilos, ramulis acute angulatis. Foliis lanceolatis v. angusto-lanceolatis, paullo falcatis, 5 – 7·5 cm. longis et 5 – 7 mm. latis, venis duabis prominentibus longitudinalibus et numerosis tenuibus parallelibus. Spicis gracilibus non densissimis longitudinem 4 cm. attinentibus. Floribus 5-meris. Calyce latiusculo, semi-truncato, loborum marginibus ciliatis. Petalis basi connatis vel liberis, glabris. Pistillo breve tomento tecto.

Leguminibus tenuibus translucentibus rectis, 5 cm. longis, 6 – 7 mm. latis, valvarum marginibus incrassatis, valvis bullatis, seminibus fere transverse dispositis.

Funiculo filiforme secundum duas plicas in arillum paullo incrassatum terminante.

A shrub, glabrous except for a few hairs, with acutely angular branchlets. Phyllodia lanceolate or narrow lanceolate, slightly falcate, narrowed at both ends, two to three inches (5 – 7·5 cm.) long and 5 – 7 mm. broad, slightly curved at the apex, with a rudimentary gland usually near the apex and one always near the base, with two prominent

longitudinal veins and numerous finer veins parallel theréto, the whole phyllode covered with minute resinous dots.

Spikes slender, not very dense, attaining a length (as measured by an almost glabrous rhachis) of 4 cm. ($1\frac{1}{2}$ inch). Flowers 5-merous. Calyx broadish, semi-truncate, with ciliate edges to the lobes. Petals united a little way up or free, glabrous. Pistil covered with a short tomentum.

Pods (described from No. 25). Thin, translucent, straight, 5 cm. long, width 6–7 mm., abruptly and sharply pointed at apex, somewhat abruptly tapering into a filiform pedicel of about 5 mm. Margins of valves thickened, valves embossed, the seeds arranged almost transversely. Funicle filiform, terminating after two or three folds in a slightly thickened arillus.

Mueller's No. 93, Lower Victoria River, Northern Territory, is taken as the type, while Mueller's No. 25, from the Roper River, is taken as the co-type.

It is named in memory of my only son, Harrie Hammond Maiden, who for years before his untimely death, was my companion in the bush, and an assiduous observer and collector of plants.

Range.—Northern Territory (Arnhem's Land) and Northern Queensland, extending across the tropical portions of both political divisions. The Victoria River embouches close to the Western Australian boundary, hence later I expect to find the plant in tropical Western Australia; the Roper runs into the western portion of the Gulf of Carpentaria. On the other (eastern) side of the Gulf, the Cloncurry Road, Normanton, is towards the south-eastern angle of the Gulf, while the Etheridge River is more to the east. The Etheridge runs into the Einasleigh which runs into the Gilbert, which flows into the eastern side of the Gulf. Georgetown is the chief settlement on the Etheridge.

Affinities.

1. With *A. plectocarpa* A. Cunn. The phyllodes of *A. Hammondi* are much smaller, are usually two-nerved, while those of *A. plectocarpa* are three or many nerved. The flowers are different, those of *A. plectocarpa* having hairy, linear sepals, while the calyx of *A. Hammondi* is broadish and semi-truncate, with cilia. The fruits of *A. plectocarpa* are coarser and more opaque, with the seeds more deeply embossed and differently arranged in the pod.

I know no close relations of *A. Hammondi*, but that is perhaps because our tropical Acacias have been so imperfectly worked out. We have several Acacias with straight, flattish, embossed pods, but none small and of a waxy lustre.

21. A. TUMIDA F.v.M.

Isle Lacrosse, N.W. Coast. A. Cunningham.

"A tree to 30 feet; trunk to 10 feet; diam. 9 in.; bark dark coloured, smooth; timber brownish, and rather hard; phyllodia glaucous." (W. V. Fitzgerald, MSS.)

22. A. RETINERVIS Benth.

Cape Pond, N.W. Coast, A. Cunningham.

23. A. HOLOSERICEA A. Cunn.

Cambridge Gulf, N.W. Coast, A. Cunningham; Nickol Bay, F. Gregory's Expedition. Cunningham (M.S. Journal Vol. II, p. 78) collected it at Cambridge Gulf, 22nd September, 1819.

"Tall shrub to a tree of 30 feet; trunk to 8 feet; diam. 9 in.; bark dark coloured, smooth; timber brown and moderately hard." (W. V. Fitzgerald, MSS.).

24. A. DIMIDIATA Benth.

"Various parts of the N. Coast, A. Cunningham." Most of Cunningham's collecting in Northern Australia was done in the Nor-West. I admit this from the Nor-West, though with some doubt.

25. A. Farnesiana Willd.

N.W. Coast, A. Cunningham. Nickol Bay, F. Gregory's Expedition.

26. A. suberosa A. Cunn.

Vansittart Bay and Careening Bay, A. Cunningham. Glenelg Bay, J. Martin.

"A tree of fir-like aspect, to 40 feet; trunk to 15 feet; diam. 1 foot; bark dark grey, thick, rough and corky; timber pale and rather tough; peduncles thick, bracteate, solitary, axillary, shorter than the leaves; flowers 5-merous, usually about six in a head which is subtended by a prominent lobed cupular bracteole, each flower about 2 lines long, slightly sericeous; calyx infunduliform, lobed to about one-third of its length; corolla exceeding the calyx by $\frac{1}{2}$ line, greenish, very shortly lobed, the lobes scarcely acute; stamens pale yellow, $1\frac{1}{2}-2$ lines long; pod to 9 in. long, $\frac{1}{3}$ in. broad. On grassy black soil plains, occasionally in sandy loam. 'Mimosa.' A splendid forage plant." (W. V. Fitzgerald, MSS.).

9. *Mueller.* "Plants of North Western Australia," enumerated by Baron Ferdinand von Mueller. fcp. Govt. Printer, Perth, 1881. (Presented to the Legislative Council 1880). It contains two Parts:—

(1). "Enumerative notes on the plants collected during Mr. *John* Forrest's Trigonometrical survey of the Nickol Bay district during the year *1878*." (pp. 3—13).

(2). "List of the plants collected during Mr. *Alexander* Forrest's Exploring Expedition in *1879* between Nickol Bay and King's Sound." (14—19).

i. In Part I we have:—

27. *A. sentis* F.v.M. Nickol River, A. Forrest.

13. *A. hemignosta* F.v.M. Yule River, J. Forrest.

28. *A. gonocarpa* F.v.M. var. *lasiocalyx* F.v.M. "A variety (unless a distinct species) with more perceptibly margined phyllodia, the calyces and base of corolla beset with short yellow hair." Yule and Fortescue Rivers, Jones' Creek and George's River. J. Forrest. (Prof. Ewart tells me it is no longer in the Melbourne Herbarium).

In Part II, we have

5. *A. hippuroides* Heward from three localities between 17 and 18° S. Lat. and 121 – 123° E. Long.

A. sentis and *A. gonocarpa* are new records.

ii. *Mueller.* "Catalogue of plants collected during Mr. Alexander Forrest's geographical exploration of North West Australia in 1879." Proc. Roy. Soc. N.S.W., xiv, 81 (1880). These are King's Sound to Darwin, and are therefore both Northern Territory and Nor-West. More specific localities are, however, given with each species. (In Despeissis, p. 20, there is an account of the results to Nor-West Settlement of A. Forrest's Expedition).

Mueller refers to the circumstance that, when the Parliamentary Report was published, only the Nickol Bay to King's Sound specimens were available, and says that Mr. James C. Carey also assisted in the collection. He also adds some hitherto unrecorded data from the A. C. Gregory Expedition of 1856, of which he was botanist and which mainly traversed the Northern Territory.

The Nor-West Acacias recorded appear to be:—

29. *A. retivenia* F.v.M. Margaret River.

15. *A. Wickhami* Benth. Margaret River.

30. *A. stipulosa* F.v.M. East of the Oscar Ranges, Humbert River.

31. *A. pallida* F.v.M. Margaret River.

So that *retivenia*, *stipulosa* and *pallida* are new records.

32. *A. sclerosperma* F.v.M. in Wing's Southern Science Record, II, 150 (1880), is recorded from the Nickol River, and probably from this Expedition. It is a new record.

10. "Report (s) on the Geology of the Kimberley district" by Edward T. Hardman, Government Geologist, Perth, printed by order of the Legislative Council; 1884, pp. 22, 16 plates and a map; 1885, pp. 38, 26 plates and a map, contain no botany, but the admirable lithographic views are most helpful to the botanist.

11. *King, H. S.* (1885). Mr. F. S. Brockman, Surveyor-General of Western Australia, informs me that "Mr. King conducted a triangulation and feature survey from the North West bend of the Lyons River northward to the Ashburton, and North-westward to the Fortescue Rivers, during the middle six months of the year 1885. This survey covered the country shown by flat blue wash on map attached. (Not reproduced, but filed in the National Herbarium, Sydney).

"This would be the occasion on which the plants referred to by the Government Botanist, Sydney, were collected, these plants though (I understand from Mr. King) having been forwarded for classification to the late Baron von Mueller."

They were described in a paper entitled "Plants collected in Capricornic Western Australia, by H. S. King Esq., and recorded by Baron von Mueller" etc. (Proc. Roy. Soc. Vict., XXIII, 49 – 57 (1886).

12. *Mueller.* "Descriptions of two hitherto unrecorded West Australian plants." Proc. Linn. Soc. N.S.W., XIII, 162 (1888). Although it takes cognizance of some King's Sound plants, there are no Acacia records from the Nor-West.

13. *Mueller.* In Proc. Linn. Soc. N.S.W., XIII, 1256 (1888), Mr. J. J. Fletcher communicated to the Society a list of plants collected by Mr. W. W. Froggatt (employed by Hon. W. Macleay, M.L.C.) at King's Sound. The determinations were by Mueller.

The Acacias amongst them are:—

27. *A. sentis* F.v.M.
33. *A. impressa* F.v.M.
14. *A. flavescens* A. Cunn. (probably = *A. sericata*).
34. *A. drepanocarpa* F.v.M.

A. doratoxylon F.v.M. (probably *A. proxima* n. sp., see No. 58).

A. impressa and *drepanocarpa* are new records.

14. *Mueller.* "Observations on plants collected during Mr. Joseph Bradshaw's Expedition to the Prince Regent's River." Proc. Linn. Soc. N.S.W., XVI, 457 (1891).

This was a private expedition from Cambridge Gulf to Prince Regent's River, and the collection of plants, entrusted to Mr. William Tucker Allen, was well done.

The Acacias collected were:—

11. *A. translucens* A. Cunn. Roe's River.
4. *A. lycopodifolia* A. Cunn. Woodhouse and Pentecost Rivers.
13. *A. hemignosta* F.v.M. Prince Regent's River.
14. *A. sericata* A. Cunn. (recorded as *A. flavescens*—a matter of opinion).
35. *A. Kelleri* n. sp. Durack River.
26. *A. suberosa* A. Cunn. Carson River.
31. *A. pallida* F.v.M. Carson River.

A. Kelleri is a new record.

15. *Tepper, J. G. O.* "The Flora of Roebuck Bay, West Australia." Proc. Roy. Soc. S.A., XVII, 13 (1893).

The collections were made by the writer's son (J. W. O. Tepper) 1889-91, and most of the determinations were made by Mueller. The specimens were collected in a very dry season, at four localities. Most of them were collected near the modern Broome.

The Acacias enumerated are (with the original query marks):—

4. *A. lycopodifolia* A. Cunn.
23. *A. holosericea* A. Cunn. 4–6 feet.
(?) 21. *A. tumida* F.v.M.
(?) *A. acuminata* Benth. (This is *A. proxima* n. sp. See No. 55).
1. *A. bivenosa* DC. 4–5 feet.
(?) *A. signata* F.v.M.
(?) 32. *A. impressa* F.v.M.

A. signata would be a new record, if confirmed.

Tepper, *J. G. O.* "Die Flora von Roebuck Bay, Nord-West Australien." Botan. Centralb. No. 22, (1893).

Practically the same as the preceding paper, but the query marks are removed from the Acacias, doubtless through inadvertence.

16. *Tate, Prof. Ralph.* "A list of plants collected by the Calvert Expedition." Proc. Roy. Soc. S.A., XXI, 69 (1897).

The collection was made by Mr. G. Keartland and is supplemental to the collections abandoned at Joanna Springs owing to the disaster. "It was made . . . while stationed at the junction of the Fitzroy River and Margaret Creek, about 150 miles from Derby; and secondly, whilst on the search for his missing colleagues, embracing 100 miles down the Fitzroy, thence south to near Joanna Springs, and thence to Derby."

"The facies is that of the Eremæan botanical province, largely composed of Indo-Australian species such as prevails over the tableland skirting the littoral tracts of North Western Australia."

The Acacias enumerated are:—

36. *A. dineura*	37. *A. stipuligera*
21. *A. tumida* F.v.M.	26. *A. suberosa*

See also "Journal of the Calvert Scientific Exploring Expedition, 1896-7," fcp. pp. 62, maps and plans. Published by the Western Australian Parliament, 1902. See also "The Calvert Scientific Exploring Expedition," by J. G. Hill, sm. 4to. pp. 44 (1905) with map showing the route.

A. dineura and *A. stipuligera* are new records.

17. *Helms, Richard.* "East Kimberley." Journ. Bureau Agric. W.A., 2nd, 16th, and 30th June, 1897. A valuable paper, containing notes on the natural vegetation, absence of forests, reforesting the country and list of trees and other economic plants for introduction.

18. *Brockman, F. S.* "Report on Exploration of North-West Kimberley, 1901, by Fred. S. Brockman, Chief Inspecting Surveyor (Leader), with Appendices by Chas. Crossland (Second in Command) and Dr. F. M. House (Naturalist and Botanist). Fcp. pp. 1 – 19, 51 – 59, with 28 photos, chiefly of ethnographical interest, and a map (Govt. Printer, Perth, W.A., 1902). The botanical references are few. At p. 10 it is stated that specimens of the principal grasses had been forwarded to the Agricultural Department.

"In no part of the country did I find timber or any indigenous product (other than grass) of any commercial value. The Cypress Pine is I believe, the same that is used in Queensland for fencing and building, and, as it grows to a fair size and length, it should be suitable for those purposes locally."

Dr. House (p. 17) states that . . . "the duties of packing horses and attending to all my personal wants left little time for anything else in the intervals of travelling." At p. 18, he notes that the natives stupefy fish by using the "root of a shrub which grows along the banks of all these rivers, and which is known on the Fitzroy River as Majalla." On p. 19 he states, "a number of botanical specimens were

obtained, but the wild flowers of this region are very much less numerous than in the southern part of the State. Ferns of considerable beauty and growing in great profusion, were found in some of the gorges. Unfortunately the grasses of the basalt country were not in flower and the seed had all dropped. The distribution of the curious baobab tree is somewhat remarkable, the area over which it grows being very restricted and apparently dependent to a great extent on the nature of the soil."

The results of this Expedition were briefly described by Mr. Fraser in the W. A. Yearbook for 1900-1, p. 72.

At p. 4 of his report, Mr. Fitzgerald referred to Dr. House's collection as "small," and most, if not all the species were collected later by him (Mr. Fitzgerald). At p. 11 it is stated that Dr. House's collection consists of solitary specimens of less than 100 species, many of them fragmentary.

19. *Pritzel, E.* E. Pritzel in Diels and Pritzel, Engler's Bot., Jahrb. XXXV, (1905) collected

11. *A. translucens* A. Cunn.
39. *A. xiphiophylla* n. sp.
38. *A. sphærostachya* n. sp.
40. *A. trachycarpa* n. sp.

A. camptoclada n. sp. All at or near Roeburne.

The name *A. camptoclada* being preoccupied, see below, I have suggested No. 55, *A. proxima* for it.

55. *A. proxima* n. sp.

Synonyms (1) *A. camptoclada* E. Pritzel in Engler's Bot. Jahrb., XXXIV, 309 (1905). This name is preoccupied by *A. camptoclada* Andrews, Journ. W. A. Nat. Hist. Soc. 39 (May, 1904), a species aff. *A. undulifolia* A. Cunn.

(2) (?) *A. acuminata* Mueller or Tepper non Benth. in Proc. Roy. S.A., XVII, 17, (1893).

This has been looked upon by some observers as *A. doratoxylon* A. Cunn., but no pods are available in the case of

any Tropical West specimen known to me. We must therefore suspend our judgment. As it has been separately described, and for other reasons, it will be convenient to refer to it by name. I suggest that of *A. proxima.*

Pritzel, comparing it with *A. doratoxylon*, says that it differs in having 1 – 3 nerved phyllodes, looser spikes, and the slender peduncles longer. There is a gland at the base of the phyllode, consisting of a small circular orifice, which does not appear to be in normal *A. doratoxylon* A. Cunn. Flowers 5-merous on a long spike, somewhat scattered. Calyx roundly lobed, covered in hair. Petals divided partly down, glabrous. Pistil very small, glabrous.

A specimen near to the above, from Meda, (Dr. H. Basedow, No. 7, April, 1916), shows the following variation from typical *A. doratoxylon*—flower spikes in clusters as many as four in one group, not racemose as in *A. doratoxylon.* Gland a circular orifice. Phyllodes somewhat mealy, or less striate than *A. doratoxylon.*

20. *Fitzgerald, W. V.* "Reports on Portions of the Kimberleys (1905-6)," fcp. pp. 18 with a map. Perth, Government Printer, 1907. The reports are two and were addressed to the Surveyor-General.

(1) "Report on a portion of West Kimberley, (1905)."

Mr. Fitzgerald was attached to Mr. C. Crossland's party, and the report covers pp. 3 – 14. The first paragraph of p. 3 shows the route traversed. At pp. 11 – 13 is a useful botanical resumé, and it is to be regretted that the lists of the plants found, and here referred to, were not published.

At p. 11 he makes the statement, "Prior to the determination of my data, within the ordinal limits already mentioned, there were recorded from tropical Western Australia 985 species. These are now augmented by 268, making a total to date of 1253 species, inclusive of 89 which

are new to science. Eleven species indigenous in India are now recorded as Australian." At the same page he speaks of "Mimosa" (*Acacia suberosa* and *A. Bidwilli*) occurring on the richer grassed plains, called "Mimosa plains," and the foliage of both species is readily eaten by stock.

(2). "Report on portions of the Kimberleys (1906)."

This occupies pp. 15–18 (in the second paragraph of p. 15 there is an account of the route), and there is a brief botanical note at p. 16 in which the author says, "The 1905–1906 collections have added 319 species to our tropical flora, which now, from Dilleniaceæ to Filices inclusive, comprise 113 Natural Orders to 1304 species."

These numbers are E. and O. E. as accountants say, and Mr. Fitzgerald's are the only figures, of which I am aware, referring to tropical Western Australia in contradistinction to the "N.A." of Bentham and Mueller, and to which I have referred in my account of the Acacias of the Northern Territory.[1]

At p. 16 attention is drawn to small collections by Messrs. Mayo Logue and J. P. Rogers. On the same page is an account of Sunday Island (Eewin)[2] which really consists of three islands at the entrance of King Sound. Brief notes on the vegetation will be found at p. 18.

Some of Mr. Fitzgerald's specimens came into my care through purchase from a person into whose hands they had passed, and some of the Eucalypts have been described by me.[3]

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[1] The title of the work (in the press) is "The Flora of the Northern Territory," by Alfred J. Ewart, D.Sc., Ph.D., etc., and Olive B. Davies, M.Sc. with the co-operation of J. H. Maiden, E. Cheel, and A. A. Hamilton.

[2] Sunday Island (Ewenu), King Sound, Kimberley is described by W. D. Campbell and W. H. Bird, in Proc. Roy. Soc. W.A., I, 55. At p. 58 is an account, with native names, of some of the most important plants, but no botanical names are given.

[3] This Journal, XLVII, p. 221; XLIX, 317, 318.

Some of Mr. Fitzgerald's Acacias from the herbarium of the W.A. Department of Agriculture (received by me from Dr. F. Stoward) are published in the present paper. Mr. Fitzgerald's manuscript quoted, was sent by him to me on the eve of his departure on active service in April, 1916, although I did not read the greater part of it until December, I hope that the rest of the manuscript, at all events that which refers to new species, will soon be published. It would appear that some of the corresponding specimens have been very much dispersed, and no complete set of them exists; this is to be regretted as the collection is the most important tropical West Australian one ever made.

In the "Western Mail" (Perth, W.A.), issues of 2nd, 9th and 16th June, 1906, Mr. Fitzgerald figured (small photographs) a number of new or rare species from the Kimberleys, some of the names being still apparently *nomina nuda*. The only Acacia he figured was "The fir-like Acacia" (*A. suberosa* A. Cunn.).

Some of Mr. Fitzgerald's manuscript has already been recorded in this paper as supplementary to the observations of Bentham in the Flora Australiensis; the species Mr. Fitzgerald has recorded as new for the tropical west are as follows:—

41. A. Luehmanni F.v.M.

Inglis' Gap, King Leopold Ranges; Packhorse Range. Diffuse, 3 – 4 feet high, and as much across, more or less viscid. In sandy soil (W.V.F.).

42. A. lysiphlœa F.v.M.

Inglis' Gap, King Leopold Ranges; Packhorse Range; Hann River. Diffuse, 3 – 8 feet high; bark reddish, rather rough and curly; phyllodia somewhat viscid; valves of the pod hirsute. In sandy soil (W.V.F.).

43. A. linarioides Benth.

Bold Bluff; Isdell and Denham Rivers; Dillen's Springs. Erect, 6 – 10 feet; bark reddish, rough and curly; phyllodia

viscid, sometimes above 3 in. long; spikes to 2 in. long, on slender peduncles of above 1 in., usually solitary; sepals very small, slightly ciliate; pod frequently $2\frac{1}{4}$ in. long, 2 lin. broad, very viscid, glabrous or scantily pilose. Among sandstone and quartzite rocks (W.V.F.).

44. A. LIMBATA F.v.M.

Dillen's Springs. Erect, 3–4 feet. On stony flats (W.V.F.).

45. A. CONSPERSA F.v.M.

Peduncles solitary or several together, $\frac{1}{2}$ in. or more in length, pubescent; spikes slender, about 1 in. long; flowers hirsute, mostly 5-merous; sepals linear, almost free, nearly or quite as long as the corolla; petals connate to above the middle, with scarcely evident midribs, the tips thickened, (no locality quoted). (W.V.F.)

46. A. OLIGONEURA F.v.M.

Edkins Range; Calder River. Erect, 6–8 feet. In sandy soil. (W.V.F.)

What is *A. oligoneura* F.v.M.?

It was described by Mueller in Journ. Linn. Soc. III, 139 (1859), in words, of which the following is a translation:—

Glabrous, with graceful angular-compressed branches, with phyllodes chartaceous, subsessile, elongated, narrow-lanceolate, acuminate gradually towards the apex, and narrowed towards the base, slightly falcate, trinerved, reticulately veined, glandular at the base, the veins close to the base confluent with the lower margin, no marginal glands, rhachises axillary, solitary or fasciculate, short, cylindrical, glabrous, peduncles slender, calyx broadish, membraneous, dentate, a third of the length of the corolla, pods—(wanting).

In Arnhem Land near MacAdam Range, No. 96; Victoria River, No. 95.

Phyllodes mostly 4 – 6 inches long, half an inch broad. Flowering spike half an inch long or a little more.

Bentham, who edited Mueller's paper, added,—"*Acacia delibrata* All. Cunn. ex Benth. in Hook. Lond. Journ. Bot. I, 374, var. ?" He also made the following note:—

["The specimens Nos. 95 and 96 are in young seed, and Cunningham's are out of flower with a loose fruit; but, as far as these materials admit of identification, they appear to belong to the same species; the phyllodes are, it is true, longer and not so coriaceous; but so they are in some of Cunningham's specimens. Dr. Mueller's specimen No. 91[1] from Fitzmaurice River, is exactly like one of Cunningham's except with rather more coriaceous phyllodia; it is in good fruit, and the pod similar to Cunningham's. The specimens Nos. 71, 90, and 92[1] came from Sturt's Creek, No. 25[1] from Roper, No. 40[1] from Seven Emu River, and No. 93[1] from Lower Victoria River, have still more coriaceous phyllodia, and, in the case of the two last, considerably shorter; but they probably all belong to one species."]

In the key in B. Fl. II, 317 Bentham contrasts *A. delibrata* with *A. oligoneura* in the following words (I leave out reference to the pods, as those of *A. oligoneura* are unknown).

> Phyllodia sprinkled with a few hairs.........*delibrata*
> Phyllodia very glabrous, the smaller veins between the three principal nerves scarcely conspicuous.......................*oligoneura*

At p. 405 he gives a description of *A. oligoneura* and adds, "possibly the same as *A. delibrata*." The original descriptions tell us of the phyllodes, the remarkably short spikes, and the calyx. The petals are not described, nor was the pod seen.

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[1] *Op. cit.*, p. 138 attributed to *A. delibrata* by Mueller. At p. 139 remarks on these and other numbers, with some doubt, are made by Bentham, Nos. 25 and 93 are, however, *A. plectocarpa* A. Cunn., var. according to specimens in the Kew Herbarium (*A. Hammondi* n. sp., of the present paper). See p. 95.

Mueller's "Iconography of Australian Acacias" does not help us in regard to the position of *A. oligoneura*, for he does not figure it, while his plate of *A. delibrata* is not that species, see p. 86.

The numbered specimens in the original description are not available, and most of them are doubtfully attributed to *A. delibrata*. When discovered, the material must be closely compared with that of *A. delibrata* A. Cunn. I am of opinion that *A. oligoneura* is too uncertain a species to deal with in the present state of our knowledge, and it may perhaps have to be abandoned. I should be very grateful for a sight of material attributed to *A. oligoneura*.

47. A. AULACOCARPA A. Cunn.

Goose Hill, near Ord River; Dillen's Springs. Tree to 30 – 40 feet, trunk 10 – 15 feet; diam. to above 1 foot; bark dark grey, roughish; timber brown and tough. In sandy loam. (W.V.F.)

48. A. HUMIFUSA Benth.

Summits of Mounts Browne and Leake; Bold Bluff. Stems depressed, 1 foot long. Among sandstone and quartzite rocks. (W.V.F.)

49. A. BIDWILLI Benth.

Near Wyndham; Ord, Denham, King, Isdell, Adcock, Barnett, Hann and Charnley Rivers. Shrub to tree of 30 feet; trunk to 10 feet, diam. 1 foot; bark dark coloured, rough and corky; timber pale and rather soft; branchlets, leaves and pods finely villous; a conspicuous gland above the base of each petiole; flowers white, scented. In the black soil of grassy plains. "Mimosa," a splendid forage plant. (W.V.F.)

50. A. SALICINA Lindl. var. VARIANS Benth.

"Isdell, Adcock, Charnley, Fitzroy Rivers; northern base of Mount Brennan. Tree of 30 feet; trunk to 10 feet;

diam. 1 foot; bark dark coloured, roughish; timber pale, tough; flowers almost white, strongly scented. In sandy loam." (W. V. Fitzgerald, MSS. as *A. penninervis* Sieb.). See my "Forest Flora of New South Wales," Part xxxix. It occurs in the Northern Territory and Western Australia.

In addition, we have new species as follows:—

Julifloræ (Stenophyllæ).

51. A. Kimberleyensis W. V. F. n. sp.

Frutex erectus, glaber, paullo tomentosus, viscidus, ramulis gracilibus, angulatis; phyllodiis angustis vel subulato-linearibus, plerumque falcatis, prominenter 3-nervis; spicis in pedunculis brevibus, gracilibus, solitariis vel geminis, gracilissimis, 5-meris; sepalis lineari-spathulatis, liberis, corolla fere æquilongis, tenuibus; petalis medio connatis, obtusis, tenuibus; legumine lineare, compresso sed crasso, glabro, viscido, inter semina oblique partito, obtuse 6-angulato; seminibus paullo obliquis, angusto-oblongis; funiculo breve, a basi densato, breviter plicato; arillo lobato, cupulare. (Mr. Fitzgerald is not responsible for this and other Latin descriptions).

An erect shrub, with slender angular branches, glabrous or slightly tomentose and more or less viscid; phyllodia narrow- to subulate-linear, usually falcate, with a short obtuse hooked point, much flattened, but rigid, prominently 3-nerved, with occasionally a fainter one between; spikes on short slender peduncles, solitary or two together, very slender, the flowers closely approximated, small, mostly 5-merous; sepals linear-spathulate, quite free, nearly or quite as long as the corolla, thin; petals connate to the middle, obtuse, thin; pod linear, compressed but thick, shortly acuminate, glabrous and somewhat viscid, obliquely partitioned between the seeds; valves dehiscing elastically from the apex downwards, firm, with a slightly raised longitudinal angle or rib on each side between the suture and the centre of the valve, striate between, the whole pod

obtusely 6-angled; seeds slightly oblique, narrow-oblong, shining, greenish-black; funicle short, much thickened from the base, shortly folded and terminating in a lobed cupular pale coloured basilar arillus.

Packhorse Range, Kimberley district. Amongst sandstone. (W.V.F.)

Height 3 – 5 feet. Phyllodia 3 – 5 in. long, $\frac{3}{4}$ line broad. Spikes 1 in. or less. Pod 3 – 4 in. long, nearly 2 lines across. Seeds 3 lines long.

Affinities to *A. oncinophylla* Lindl. and *A. gonocarpa* F.v.M.

Mr. Fitzgerald has written thus far; following are my observations.

A graceful species. The young stems flattened and strongly nerved on each side from the place of the insertion of the phyllode, giving them the appearance, under a lens, of phyllodes, especially when very young. Sometimes they have three nerves, making them 3-sided (triquetrous).

Phyllodes up to 16 cm. ($6\frac{1}{4}$ inches) long, with one main nerve, two less strongly marked, and others less distinct still giving the whole a deeply grooved appearance. The attachment of the phyllodes short.

Flowers in spikes, usually in pairs. Flower 5-merous, quite glabrous. Calyx very narrow (linear), about half the length of the corolla, united at the extreme base. (Mr. Fitzgerald speaks of the sepals nearly or quite as long as the corolla, but this is not the case in any specimen of this species I have examined, nor have I seen this in any other Acacia).

Petals divided about half way down and spreading.

Seed with an arillus as broad as the seed, and tapering to the attachment to the funicle, thus forming a wrinkled,

conoid mass; the length of the seed equal to that of the funicle and its arillus.

Affinities.

1. With *A. gonocarpa* F.v.M. I think the closest affinity of this species is with *A. gonocarpa*. *A. Kimberleyensis* can be separated from *A. gonocarpa* by the more numerous and strongly nerved phyllodia, the shape and position of the gland. The flowers are very much alike. The seed of *A. Kimberleyensis* presents close resemblance to that of *A. gonocarpa*, but the funicle of the former (from the material available) appears to be a little more wrinkled than that of the latter. The pod of *A. Kimberleyensis* is narrower and less woody.

2. With *A. arida* Benth. This is another species with somewhat similar flowers, but those of *A. arida* are rather broader in the calyx-lobes, and the petals do not appear to be recurved. The original description says that the calyx is shortly lobed. According to a specimen seen by Bentham and presented by Kew to Sydney, the lobes are divided to the base. The phyllodes and stems of *A. Kimberleyensis* and *A. arida* are quite different; the phyllodes are shorter, scarcely veined, and are covered with resinous dots (as seen under a lens). The stems are terete, spotted and hoary in appearance.

3. With *A. oncinophylla* Lindl. *A. oncinophylla* Lindl. quoted by Mr. Fitzgerald, is a "heavier" looking plant with pods of a different shape, covered with a vestiture of golden hair, and is in other respects very much more remote from *A. Kimberleyensis* than *A. gonocarpa* is.

Julifloræ (Rigidulæ).

52. A. CURVICARPA W. V. F. n. sp.

Frutex diffusus, pruinosus, plus minus resinosus; phyllodiis oblongis vel lanceolato-falcatis, obtusis, apicibus glandulosis sub-

prominentibus, coriaceis; venis parallelis numerosissimis, 3 – 5 prominentioribus; spicis solitariis, densis, brevissime pedunculatis, 5-meris; calyce truncato, viscido-pubescente, corolla fere æquilongo, petalis medio connatis; nervis mediis conspicuis, apicibus incurvatis; legumine curvato annulum formante, lineare, viscido-piloso; seminibus longitudinalibus angusto-oblongis; funiculo breve, plicis pluribus incrassatis, arillo cupulare.

A diffuse shrub, hoary and more or less resinous, the branchlets rather stout and angular; phyllodia from oblong to lanceolate-falcate, obtuse with rather prominent glandular tips, of a leathery texture, the parallel veins very numerous and closely packed, 3 – 5 more prominent than the others, several confluent with the lower margin; spikes solitary, very shortly pedunculate, dense; flowers mostly 5-merous; calyx viscid-pubescent, shortly and broadly lobed, but little shorter or quite as long as the corolla; petals connate to the middle, viscid, with conspicuous midribs and incurved tips; pod curved so as to form one or more rings, linear, viscid-pilose, the valves convex and coriaceous; seeds longitudinal, narrow-oblong, shining-black; funicle short, with several thickened folds and terminating in a cupular basilar arillus.

Near the junction of the Hann and Barnett Rivers (W. V.F.). On quartzite hills.

Height 3 – 4 feet. Phyllodia mostly 3 – 4 in. long, $\frac{3}{4}$ in. or less broad. Spikes 1 in. or less. Pod 2 – 3 in. long, about 2 lines broad. Affinity to *A. acradenia* F.v.M.

The above description is by Mr. Fitzgerald; the following notes are by myself.

Calyx truncate-lobed, two thirds of length of corolla, thick, covered in coarse short hair. The calyx is a bright lemon yellow, the petals a pale yellowish salmon. Petals united half way up but easily separating, thickened tips

with a few scattered hairs. Pistil glabrous except at the top where it is crowned with a few hairs.

Affinity.—With *A. umbellata* A. Cunn. (*A. acradenia* F.v.M.)

The phyllodes of *A. umbellata* are of a finer texture than those of *A. curvicarpa;* the striate lines are edged with short hairs and the gland at the base does not project; it does project in *A. curvicarpa.* Very resinous; glabrous in *A. curvicarpa.* The flowers are very similar to those of *A. umbellata;* pistil hoary.

The seeds of *A. curvicarpa* are placed longitudinally in the thin, curved pods, filling them, are attached to the outer curve; the broad arillus suddenly tapers off into a thread-like funicle. The pod of *A. umbellata* is slightly falcate, thick, and so resinous that it is very difficult to open it. The seeds resemble those of *A. curvicarpa*, and are disposed the same way in the pod, but are smaller.

Bipinnatæ (Botryocephalæ).

53. A. PACHYPHLOIA W.V.F. n. sp.

Frutex altus vel arbor, ramulis fere teretibus, glabris. Foliis bipinnatis, pinnis 2 v. 3 paribus petiolo commune æquilongis. Foliolis 10 – 15 paribus, ovato-lanceolatis ad oblongis, cinereis, venis ascendentibus. Floribus in capitulis globosis, racemosis foliis breviores formantibus. Legumine breviter stipitato, lato-lineare, glabro, compresso. Valvis coriaceis, irregulariter striatis. Seminibus longitudinalibus, ovatis, brunneis. Funiculo crasso, arillo clavato sub basi.

A tall shrub or tree; branchlets almost or quite terete, glabrous; leaves bipinnate, the pinnæ in 2 – 3 distant pairs, at least as long as the common petiole; leaflets 10 – 15 pairs, ovate-lanceolate to oblong, callous-pointed, somewhat coriaceous, of a greyish hue, the veins ascending; flowers in globular heads and forming racemes shorter than the

leaves; pod shortly stipitate, broad-linear, glabrous, compressed; valves coriaceous, slightly convex and irregularly striate; seeds longitudinal, ovate, brown; funicle thick and terminating in almost clavate sub-basilar arillus.

Slopes of Bold Bluff; hills near C. 92, in proximity to the Synnott Range; hills by the Charnley and Calder Rivers (W.V.F.). Always on andesite.

Height to 30 feet; trunk to 10 feet, diam. 6 – 9 in.; bark dark or iron-grey, very thick, rugose, deeply longitudinally fissured and corky. Timber pale, and not very hard. Pinnæ 3 – 5 in. long, the common petiole 3 – 5 in. Leaflets $\frac{1}{2}$ – $\frac{3}{4}$ inch long. Pod 3 – 5 inch long, $\frac{1}{2}$ inch broad. Seeds fully 5 lines long. Affinity to *A. elata* A. Cunn.

(Its closer affinity is, however, with *A. pruinosa* A. Cunn. an eastern Australian species, closely resembling that species in the leaflets. The resemblance to *A. elata* is more remote. Its pods resemble those of *A. Bidwilli* Benth. Its affinities cannot usefully be further investigated in the absence of flowers. Mr. Fitzgerald apparently saw some, for he describes them "in globular heads," but he does not describe their structure. I have only seen leaves and old pods.—J.H.M.).

21. *Domin, K.* "Additions to the Flora of Western and North-western Australia." Journ. Linn. Soc. Bot. XLI, 245 (1912). This paper takes cognizance of some plants collected by Dr. E. Clement between the Ashburton and De Gray (Grey) Rivers. These are the "North-western" plants. The paper includes only Monocotyledons, Ferns, and a *Casuarina.*

22. *Cheel, E.* "Records of West Kimberley Plants collected by Dr. E. Mjoberg's Scientific Expeditions to Australia (1910 – 1913). K. Svenska Ventensk. Akad. Handl. Bd. 52, No. 10, Stockholm, 1916. I have not seen the paper. It is quoted in "Contributions to West Australian Botany"

by C. H. Ostenfeld (Dansk. Botanisk Arkiv. 1916). Following are the Acacias:—

4. *A. lycopodifolia* A. Cunn. (a form near var. *glabrescens*), Broome.

32. *A. impressa* F.v.M., Broome; West Kimberley.

21. *A. tumida* F.v.M., Broome; West Kimberley.

23. *A. holosericea* A. Cunn. "Silver Wattle," Broome; West Kimberley; St. George's River.

23. *Basedow, Dr. H.* In 1916 Dr. Basedow collected plants in North West Australia between King Island and Exmouth Gulf, and he has placed them in my hands.

The Acacias are:—

32. *A. impressa* F.v.M., Emmanuel Yards (No. 8).

45. *A. oligoneura* F.v.M., perhaps, in fruit only, Sunday Island (No. 116).

5. *A. hippuroides* Hew., Raft Point (No. 140).

54. *A. Simsii* A. Cunn., Glenelg River District. Known from Northern Territory; apparently new from Nor-West (No. 143).

19. *A. delibrata* A. Cunn., (No. 130).

15. *A. Wickhami* Benth. Glenelg River District, (No. 152).

4. *A. lycopodifolia* A. Cunn. var. *glabrescens* Benth., (No. 122). Yampi.

A. Simsii is a new record.

Following is a list of Nor-West species referred to in the foregoing:—

1. *bivenosa*
2. *patens*
3. *Bynoeana*
4. *lycopodifolia*
5. *hippuroides*
6. *Gregorii*
7. *spathulata*
8. *pyrifolia*
9. *deltoidea*
10. *setulifera*

11. *translucens*
12. *coriacea*
13. *hemignosta*
14. *sericata*
15. *Wickhami*
16. *stigmatophylla*
17. *xylocarpa*, and var. *planifolia*
18. *arida*
19. *delibrata*
20. *plectocarpa*
21. *tumida*
22. *retinervis*
23. *holosericea*
24. *dimidiata (?)*
25. *Farnesiana*
26. *suberosa*
27. *sentis*
28. *gonocarpa*
29. *retivenia*
30. *stipulosa*
31. *pallida*
32. *sclerosperma*
33. *impressa*
34. *drepanocarpa*
35. *Kelleri*
36. *dineura*
37. *stipuligera*
38. *sphœrostachya*
39. *xiphiophylla*
40. *trachycarpa*
41. *Luehmanni*
42. *lysophlœa*
43. *linarioides*
44. *limbata*
45. *conspersa*
46. *oligoneura (?)*
47. *aulacocarpa*
48. *humifusa*
49. *Bidwilli*
50. *salicina*
51. *Kimberleyensis* n. sp.
52. *curvicarpa* n. sp.
53. *pachyphloia* n. sp.
54. *Simsii*
55. *proxima* n. sp.

In addition, it has been found necessary to describe *A. Armitii*, *Hammondi*, *Hemsleyi* although not yet recorded from the Nor-West.

Classification of the Species.

PUNGENTES (UNINERVES).
patens

CALAMIFORMES (PLURINERVES).
Bynoeana

BRUNONIOIDEÆ.
lycopodifolia
hippuroides

UNINERVES (ARMATÆ).
Gregorii

UNINERVES (BREVIFOLIÆ).
spathulata

UNINERVES (ANGUSTIFOLIA)
sentis

UNINERVES (RACEMOSÆ).

pyrifolia

salicina

sclerosperma

PLURINERVES (TRIANGULARIES).

deltoidea

stipulosa

Luehmanni

PLURINERVES (BREVIFOLIÆ).

setulifera

translucens

impressa

PLURINERVES (OLIGONEURÆ).

bivenosa

Simsii

PLURINERVES (MICRONEURA).

coriacea

PLURINERVES (NERVOSÆ).

hemignosta

PLURINERVES (DIMIDIATÆ).

sericata

retivenia

dineura

JULIFLORÆ (RIGIDULÆ).

Wickhami

stigmatophylla

Kelleri

stipuligera

sphærostachya

xiphiophylla

lysophlœa

JULIFLORÆ (RIGIDULÆ).

linarioides

curvicarpa n. sp.

JULIFLORÆ (STENOPHYLLÆ).

xylocarpa

arida

gonocarpa

drepanocarpa

trachycarpa

Kimberleyensis n. sp.

JULIFLORÆ (FALCATÆ).

delibrata

Hemsleyi n. sp.

plectocarpa

tumida

retinervis

conspersa

oligoneura

aulacocarpa

proxima n. sp.

JULIFLORÆ (DIMIDIATÆ).

holosericea

dimidiata

humifusa

BIPINNATÆ (BOTRYOCEPHALÆ).

pachyphloia n. sp.

BIPINNATÆ (GUMMIFERÆ).

Farnesiana

suberosa

pallida

Bidwilli

Northern Territory Species not yet recorded from Nor-West.

aneura

amentifera

auriculiformis

brevifolia

Cambagei
conjunctifolia
continua
Cowleana
crassicarpa
Cuthbertsoni
cyperophylla
dictyophleba
difficilis
doratoxylon (?)
estrophiolata
frumentacea
galioides
Gilesiana
gonoclada
Hammondi
Kempeana
latescens
latifolia
leptophleba
megalantha
minutifolia
notabilis
oncinocarpa
Oswaldi
pachycarpa
phlebocarpa
pityoides
polystachya
prælongata
ptychophylla
sessiliceps
sibirica
spondylophylla
stenophylla
subternata
Sutherlandi
Tanumbirinense
tetragonophylla
ulicina
umbellata

List of Nor-West Species in Alphabetical Order.

N.T = Northern Territory; Q. = Queensland ; W.A. = Western Australia; S.A. = South Australia; O.S. = Other States.

arida N.T. (?)
aulacocarpa N.T. (?), Q.
Bidwilli N.T. (?), Q.
bivenosa N.T.(?) , W.A.
Bynoeana N.T., S.A.
conspersa N.T.
coriacea N.T., Q.
curvicarpa n. sp.
delibrata N.T., Q.
deltoidea N.T .(?)
dimidiata N.T.
dineura N.T.
drepanocarpa N.T.
Farnesiana N.T., O. S.
gonocarpa N.T.
Gregorii N.T. (?)
hemignosta N.T., Q.
hippuroides N.T.
holosericea N.T.
humifusa N.T.
impressa N.T.
Kelleri N.T.

Kimberleyensis n. sp.
limbata N.T.
linarioides N.T.
Luehmanni N.T.
lycopodifolia N.T.
lysiphlœa N.T.
oligoneura (?) N.T.
pachyphloia n. sp.
pallida N.T.
patens N.T.
plectocarpa N.T.
proxima n. sp.
pyrifolia N.T.
retinervis N.T.
retivenia N.T.
salicina N.T., O.S.
sclerosperma W.A.
sentis N.T., O.S.
sericata N.T., Q.
setulifera N.T. (?)
Simsii N.T., Q.
spathulata N.T. (?), W.A.
sphærostachya W.A.
stigmatophylla N.T.
stipuligera N.T., Q, O.S.
stipulosa N.T., W.A.
suberosa N.T.
trachycarpa W.A.
translucens N.T.
tumida N.T.
Wickhami N.T.
xiphiophylla W.A.
xylocarpa N.T.
Total 55.

EXPLANATION OF PLATES.

Acacia delibrata A. Cunn.

Plate I.

1. Phyllodes, covered with a fine silky tomentum; gland at base. Dries a dull olive green.

2. Pod, with short hairs on the raised parts. 1 and 2 from the type, Port Warrender, North West Australia, Allan Cunningham, No. 486, October, 1819. Presented by Kew.

3. Twig, showing phyllodes and flowering spikes.

4 and 5. Flowers, showing minor differences, the latter with recurved petals.

6. Pistil.

7. Portion of pod, showing seed, funicle and arillus *in situ*. 3 to 7 from Sunday Island, West Kimberley, (W. V. Fitzgerald).

ACACIA HEMSLEYI Maiden, n. sp.

Plate II.

1. Flowering twig from Fitzroy River, 8 miles above Hann River Junction, West Kimberley, Nor-West. (W. V. Fitzgerald, No. 1177, June, 1905).
2. Flower.
3. Pistil.
4. Floral bract.
5. Pods.
6. Seed, *in situ.*

Nos. 2 – 6 from a scrub on the Gregory River, Gregory Downs near Burketown, North Queensland (Dr. T. L. Bancroft). Note the thickened margins of the valves.

ACACIA PLECTOCARPA A. Cunn.

Plate III.

1. Phyllode (with three main nerves) from type, Cambridge Gulf, North West Australia. Allan Cunningham, No. 482, September 1819.
2. Phyllode, with three main nerves.
3. Valve of pod.
4. Seed, with arillus, natural size.
5. Seed with arillus, enlarged. 2 to 5 from co-type, Sims' Island, Northern Territory, Allan Cunningham, No. 122, 1820. Presented by Kew.
6. An exceptionally long and rather narrow phyllode. Denham River, East Kimberley, North West Australia (W. V. Fitzgerald).
7. Three spikes of flowers.
8. Single flower, showing calyx and petals.
9. Single flower, showing petals and pistil.

10. Floral bract. 7 to 10 from Isdell River, Mount Barnett homestead, West Kimberley, North West Australia. (W. V. Fitzgerald).

11. Pod.

12. Seed, with funicle and arillus. 11 and 12 from same locality as 6.

ACACIA HAMMONDI Maiden, n. sp.

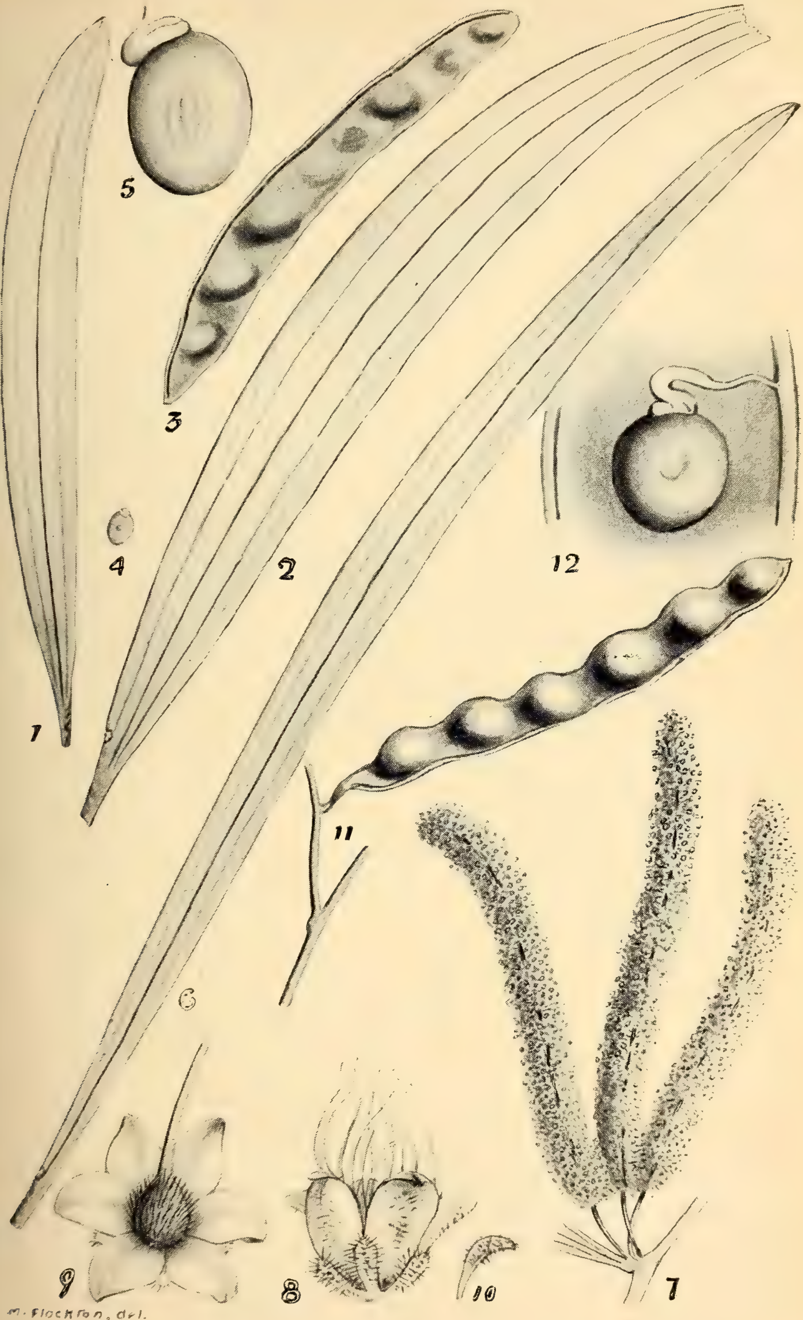
Plate IV.

1. Twig, showing two veined phyllodes, an interrupted flowering spike and a rhachis after flowering.
2. Flower.
3. Pistil. 1 to 3, Lower Victoria River, Northern Territory (Mueller, No. 93).
4. Twig, showing phyllode and pods.
5. Larger phyllode. 4 and 5, Roper River, Northern Territory (Mueller, No. 25). Bentham, when doing Acacia for the Flora Australiensis, wrote up Mueller's 93 and 25 as "*A. plectocarpa* var." Presented by Kew.
6. Twig with phyllodes and pods.
7. Portion of pod, greatly enlarged, showing seed with funicle and arillus. 6 and 7 from Etheridge River, Northern Queensland, W. E. Armit, No. 624.

I desire to acknowledge most valuable assistance I have received from Miss Margaret Flockton and Mr. W. F. Blakely, my assistants, in the preparation of this paper.

Acacia delibrata A. Cunn.

Acacia Hemsleyi Maiden, n.sp.



Acacia plectocarpa A. Cunn.

M. Flockton. del.

Acacia Hammondi Maiden, n.sp.

TABLES TO FACILITATE THE LOCATION OF THE CUBIC PARABOLA.

By C. J. MERFIELD, F.R.A.S. etc.

(Communicated by J. NANGLE.)

[*Read before the Royal Society of N. S. Wales, June 6, 1917.*]

Introduction.

In the Journal and Proceedings of this Society, Vol. XXIV, there will be found a table, prepared by the writer, which gives values of certain functions in connection with the location of the cubic parabola. The argument to this table being x/R, in which R equals ρ, the radius of curvature at the point x_c y_c where the parabola forms contact with the circular curve of radius R.

This table may be used in quite a number of ways to solve such problems that arise in practice. To illustrate, it may be desired to set out a cubic parabola when the value of h/R is given, or again the point c may be fixed on the circular curve, hence ϕ, the angle between the axis x and the tangent at the point c, becomes known, from these values the remaining functions required are readily found by the usual methods of interpolation.

To those who have a knowledge of interpolation, such problems present no difficulty, as the argument of the table is so arranged that only second differences need be taken into account in the formulæ of interpolation. The table could have been prepared so as to include values of the first derivatives for each respondent, but for the purpose for which this table was prepared it was unnecessary.

Some time ago I received a request from an officer of the Tramway Construction Department of New South Wales,

asking for solutions of certain problems in connection with tramway location. These problems were not difficult, but sufficiently so, perhaps, to cause annoyance to the practical engineer not accustomed to questions of this nature.

As the replies to these questions may be useful to others desiring similar information, it was thought advisable to combine them in a short paper for future use. Similar notation will be used here as in previous papers.[1]

Solution of Problems.

In tramway location, as practised in New South Wales, it would seem for some reason, not necessary here to explain, that the values of "h" and "R" form the data in the problem for setting out the cubic parabola to connect the straight with the circular curve. With the value of h/R we may find the several quantities usually required to set out the parabola.

Let us take the equation

$$h/R = \tfrac{2}{3} \sin^2 \phi \cos \phi + \cos \phi - 1 \ldots\ldots\ldots 1^2$$

by a simple reduction this may be put into the form

$$\text{Cos}^3 \phi - \tfrac{5}{2} \cos \phi + \tfrac{3}{2} \left(1 + \frac{h}{R}\right) = 0 \ldots\ldots\ldots 2$$

From this equation the angle ϕ may be readily determined.

Putting $\beta = \tfrac{3}{2}\left(1 + \frac{h}{R}\right)$, $\cos 3\alpha = - [9{\cdot}81774186]\, \beta$

then $\text{Cos}\, \phi = [0{\cdot}26143938] \cos \alpha$.

Example.

$h = 0{\cdot}025152$, $R = 2$, $h/R = 0{\cdot}012576$, $\beta = 1{\cdot}518864$.

Log const	$= -\ 9{\cdot}81774186$	Log const	$= 0{\cdot}26143938$
,, β	$= 0{\cdot}18151888$	,, $\cos\alpha$	$= 9{\cdot}71327467$
,, $\cos 3\alpha$	$= -\ 9{\cdot}99926074$	,, $\cos\phi$	$= 9{\cdot}97471405$
3α	$= 176^\circ\ 39'\ 28''{\cdot}42$	ϕ	$= 19^\circ\ 21'\ 45''{\cdot}2$
α	$= 58\ \ 53\ \ 9{\cdot}47$		

[1] This Journal, Vols. xxix, xxxi, xxxiv. [2] Vol. xxxi, p. 59.

Table II appended to this paper, gives values of the angle ϕ with the argument h/R between the limits 0·0000 and 0·01430. The maximum value of h/R equals

$$\sqrt{\frac{250}{243}} - 1 = 0{\cdot}01430103$$

and the angle ϕ must be within the limits $0^{\cdot\circ\cdot}$ and $\cos^{-1}\sqrt{\frac{5}{6}}$, that is between $0^{\cdot\circ\cdot}$ and $24^\circ\ 5'\ 41''{\cdot}43\ldots$

For reasons, already explained in a previous paper, these limits must be kept in view when dealing with the cubic parabola as an easing curve.

It would also appear that the tramway practice in New South Wales adopts the cubic parabola merely as a curve to connect the straight with the circular arc, and not necessarily to overcome the superelevation of the outer rail on the curves. Under these circumstances it becomes feasible to adopt a radius of curvature for the parabola equal to or greater than that of the contact curve at the point of contact $x_c\ y_c$.

In some cases a small length of circular arc of larger radius than the circular curve, has been introduced between the parabola and the main curve, so that the curve leading out of the straight would consist of the parabola, a small length of circular arc of radius R_2 then the main curve of radius R_1. It would be much better to eliminate the small length of arc of radius R_2 by simply finding a cubic parabola having a radius of curvature say R_2 at the point of contact c the coordinates of which are $x_c\ y_c$.

Under the conditions just formulated, there will be two cases. Firstly, we may fix a point c on the circular curve, hence ϕ and y_c become known. Provided the point c is so fixed, that the angle ϕ is within the limits already mentioned, then we may find a cubic parabola that will connect the straight with the circular curve so that the tangent at

c will be common to both. Secondly we may adopt a value of ρ the radius of curvature of the cubic parabola at the point of contact c.

Thus

$$R_2 = \frac{y_c}{\left(1 + \frac{h}{R_2}\right) - \cos\phi} \text{.........3}$$

in which h/R_2 corresponds to ϕ and may be found from the tables and

$$\begin{aligned} y_c &= R_1\ (1 - \cos\phi) + a \text{.........4} \\ &= R_1 \text{ Versin } \phi + a \end{aligned}$$

we also have

$$R_2 = \frac{3\ y_c}{2 \sin^2\phi \cos\phi} \text{.........5}$$

probably more useful than (3) as we avoid the calculation of h/R_2.

Having determined R_2 we may readily find

$$\begin{aligned} x &= 2\ R_2 \sin\phi \cos^2\phi \text{............5}a \\ x' &= R_2 \sin\phi \\ h &= y_c - R_2 \text{ versin } \phi \\ T\,K &= (R_2 - R_1) \sin\phi \\ mR_2^2 &= \frac{1}{12 \sin\phi \cos^5\phi}. \end{aligned}$$

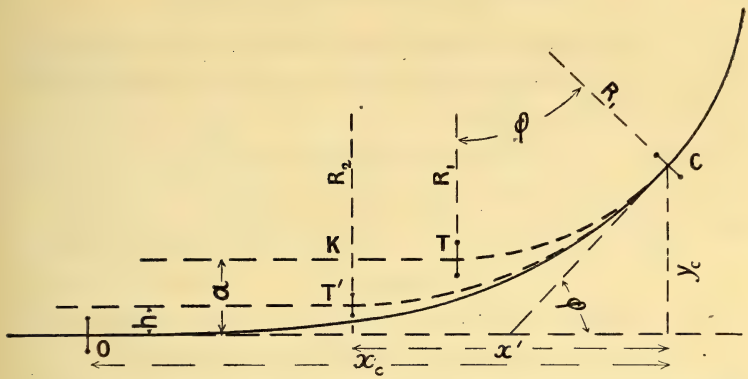
or with the value x/R_2 the several quantities may be found from the table given in Vol. XXXIV, page 285.

Let us now take the second case when we adopt a radius of curvature ρ, equals R_2 at the point of contact c.

From the theory explained in previous papers we may readily deduce the following equation

$$\text{Cos}^3\phi - \left(1 + \frac{3\ R_1}{2\ R_2}\right) \cos\phi + \frac{3\ (R_1 + a)}{2\ R_2} = 0 \text{.........6.}$$

In this and previous formulæ the quantity "a" represents the distance between the parallel tangents, see Fig. When in equation (6), R_2 equals R_1 and "a" equals "h," it reduces to the form given in (2).



To determine the value of ϕ from the above equation let us put

$$n = \sqrt{\frac{4}{3}\left(1+\frac{3\,R_1}{2\,R_2}\right)} \text{ and } \beta = \frac{3\,(R_1 + a)}{2\,R_2}$$

$$\text{Cos } 3\alpha = -\,4\,\beta/n^3$$

then $$\text{Cos } \phi = n \text{ Cos } \alpha.$$

Example.

$R = 68 \qquad R_2 = 165 \qquad a = 3{\cdot}14$

Log β =	9·8107212	Log n =	0·1669830
,, − 4 =	−0·6020600	,, cos α =	9·8235023
	−0·4127812	,, cos ϕ =	9·9904853
Log n^3 =	0·5009490		
,, cos3α =	−9·9118322	ϕ =	11° 56′ 58″·8
3 α =	144° 42′ 46″·2		
α =	48 14 15·4		

$$y_c = \tfrac{2}{3}\,R_2 \sin^2\phi \cos\phi = R_1 \text{ versin } \phi + a$$

from which we find y_c, equals 4·61358, and from the equation

$$\left(1 + \frac{h}{R_2}\right) = \cos\phi\,(1 + \tfrac{2}{3}\sin^2\phi) \quad \text{.........7}$$

we may find "h." To simplify the numerical calculation of this equation we may put

$$\left(1 + \frac{h}{R_2}\right) = 2\cos\phi\cos^2\tfrac{1}{2}\psi.$$

$$\text{Cos } \psi = \tfrac{2}{3}\sin^2\phi.$$

From Table I appended to this paper we may determine x/R^2 with the argument ϕ, then h/R_2 can be found from the table of Vol. XXXIV.

The arc $\qquad TC = [8{\cdot}2418774]\ R_1\phi^{\cdot\circ\cdot}$

To fix the point "K" opposite T' we have

$TK = (R_2 - R_1) \sin\phi. \quad x' = TK + R_1 \sin\phi = R_2 \sin\phi.$

Tables.

Table I gives the values of x/R with the argument ϕ. This table has been prepared from the equation 5a.

Table II contains ϕ with the argument h/R. Equation (2) has been used in its preparation.

In both tables the numerical values of the derivatives ω $F'(t)$ are tabulated and facilitate interpolation. We have for a given value of h/R

$$\phi_n = \phi_\circ + n\left\{\omega F'_\circ(t)\right\} + \frac{n^2}{2}\left\{\omega F'_1(t) - \omega F'_\circ(t)\right\} \ldots\ldots 8$$

or we may write

$$\phi_n = \phi_1 - (1-n)\left\{\omega F'_1(t)\right\} + \frac{(1-n)^2}{2}\left\{\omega F'_1(t) - \omega F'_\circ(t)\right\} \ldots 9$$

If we write h/R in place of ϕ, then the formulæ apply equally well for the interpolation from Table II, they are general.

The notation of these formulæ will be understood from the following example of their application.

Example.

Find the angle ϕ from Table II when h/R equals 0·0109428.

Therefore $n = 0{\cdot}428$

$$\omega F'_\circ(t) = +\ 7'\ 17''{\cdot}9. \qquad \omega F'_1(t) = +\ 7'\ 21''{\cdot}5$$

$$\tfrac{1}{2}\left\{\omega F'_1(t) - \omega F'_\circ(t)\right\} = +\ 1''{\cdot}8$$

and

$$\begin{aligned}\phi_n &= 17^\circ\ 7'\ 6''{\cdot}7 + (0{\cdot}428) \times 7'\ 17''{\cdot}9 + (0{\cdot}428)^2 \times 1''{\cdot}8.\\ &= 17^\circ\ 14'\ 26''{\cdot}4 - (0{\cdot}572) \times 7'\ 21''{\cdot}5 + (0{\cdot}572)^2 \times 1''{\cdot}8.\\ &= 17^\circ\ 10'\ 14''{\cdot}4\end{aligned}$$

In Table II the interval between the arguments has been diminished so as to avoid additional terms in the formula of interpolation. The value of "n" must therefore be reduced to the proper unit by dividing "n" by ω, the interval of the argument.

If we desired to find the value of ϕ corresponding to h/R equals 0·0132572 then

$$2n = 0{\cdot}0132572 - 0{\cdot}01324 = 1{\cdot}72$$
$$n = 0{\cdot}86 \text{ and } (1 - n) = 0{\cdot}14$$

If the value of "n" exceeds 0·5 then adopt formula (9).

The values of the derivatives are not given at the beginning or end of Table II. To secure accurate interpolation would necessitate an additional term in the formulæ, and the tabulation of the higher derivatives.

When a value of h/R comes within these limits, then ϕ should be determined from equation (2) if it is not equal to one of the tabulated arguments.

The following equation forms a useful control

$$\text{Cos } \phi = 1 - \frac{a - h}{R_2 - R_1}.$$

The following typographical errors have been noted in the table Vol. XXXIV, page 285.

x/R	Tabulated.	Correct.
0·40	12° 4′ 20″·0	12° 4′ 20″·9
0·43	2·622733	9·622733.

Table I.

ϕ	x/R	$\omega F'(t)$	ϕ	x/R	$\omega F'(t)$	ϕ	x/R	$\omega F'(t)$	ϕ	x/R	$\omega F'(t)$
–o–			–o–			–o–			–o–		
0·0	0·000000	3491·0	6·0	0·206773	3358·0	12·0	0·397848	2971·0	18·0	0·559017	2369·0
·1	0·003491	3491·0	·1	0·210129	3353·5	·1	0·400815	2963·0	·1	0·56138[illegible]	2357·0
·2	0·006982	3490·5	·2	0·213480	3348·5	·2	0·403774	2955·0	·2	0·563731	2345·5
·3	0·010472	3490·0	·3	0·216826	3344·0	·3	0·406725	2946·5	·3	0·566071	2334·0
·4	0·013962	3490·0	·4	0·220168	3339·5	·4	0·409667	2937·5	·4	0·568399	2322·0
·5	0·017452	3489·5	·5	0·223505	3335·0	·5	0·412600	2929·5	·5	0·570715	2310·0
·6	0·020941	3489·0	·6	0·226838	3330·0	·6	0·415525	2920·5	·6	0·573019	2298·5
·7	0·024430	3489·0	·7	0·230165	3325·0	·7	0·418441	2911·5	·7	0·575312	2287·0
·8	0·027919	3488·5	·8	0·233488	3320·5	·8	0·421348	2902·5	·8	0·577593	2275·0
·9	0·031407	3487·5	·9	0·236806	3315·0	·9	0·424246	2894·0	·9	0·579862	2263·0
1·0	0·034894	3486·5	7·0	0·240119	3310·5	13·0	0·427136	2885·5	19·0	0·582119	2251·0
·1	0·038380	3486·0	·1	0·243427	3305·0	·1	0·430017	2876·0	·1	0·584364	2239·0
·2	0·041866	3485·5	·2	0·246729	3299·5	·2	0·432888	2866·5	·2	0·586597	2227·0
·3	0·045351	3484·5	·3	0·250026	3294·5	·3	0·435750	2857·5	·3	0·588818	2215·0
·4	0·048835	3483·5	·4	0·253318	3289·5	·4	0·438603	2848·5	·4	0·591027	2203·0
·5	0·052318	3482·5	5	0·256605	3284·0	·5	0·441447	2839·0	·5	0·593224	2190·5
·6	0·055800	3481·0	·6	0·259886	3278·5	·6	0·444281	2829·5	·6	0·595408	2178·0
·7	0·059280	3480·0	·7	0·263162	3273·0	·7	0·447106	2820·5	·7	0·597580	2166·0
·8	0·062760	3479·0	·8	0·266432	3267·0	·8	0·449922	2811·0	·8	0·599740	2154·0
·9	0·066238	3477·0	·9	0·269696	3261·5	·9	0·452728	2801·5	·9	0·601888	2141·5
2·0	0·069714	3475·5	8·0	0·272955	3256·0	14·0	0·455525	2792·5	20·0	0·604023	2129·0
·1	0·073189	3474·0	·1	0·276208	3250·0	·1	0.458313	2782·0	·1	0·606146	2116·5
·2	0·076662	3472·5	·2	0·279455	3244·0	·2	0·461091	2773·0	·2	0·608256	2104·0
·3	0·080134	3471·0	·3	0·282696	3238·0	·3	0·463859	2763·5	·3	0·610354	2092·0
·4	0·083604	3469·0	·4	0·285931	3232·0	·4	0·466618	2754·0	·4	0·612440	2079·5
·5	0·087072	3467·5	·5	0·289160	3226·0	·5	0·469367	2744·0	·5	0·614513	2066·5
·6	0·090539	3466·0	·6	0·292383	3220·0	·6	0·472106	2734·5	·6	0·616573	2053·5
·7	0·094004	3463·5	·7	0·295600	3213·5	·7	0·474836	2724·5	·7	0·618620	2041·0
·8	0·097466	3461·5	·8	0·298810	3207·0	·8	0·477555	2714·0	·8	0·620655	2028·5
·9	0·100927	3459·5	·9	0·302014	3201·0	·9	0·480264	2704·0	·9	0·622677	2016·0
3·0	0·104385	3457·0	9·0	0·305212	3194·5	15·0	0·482963	2694·0	21·0	0·624687	2003·5
·1	0·107841	3455·0	·1	0·308403	3188·0	·1	0·485652	2684·0	·1	0·626684	1990·5
·2	0·111295	3453·0	·2	0·311588	3181·5	·2	0·488331	2674·0	·2	0·628668	1977·5
·3	0·114747	3450·5	·3	0·314766	3175·0	·3	0·491000	2663·5	·3	0·630639	1965·0
·4	0·118196	3447·5	·4	0·317938	3168·5	·4	0·493658	2653·0	·4	0·632598	1952·0
·5	0·121642	3445·0	·5	0·321103	3161·5	·5	0·496306	2643·0	·5	0·634543	1939·0
·6	0·125086	3442·5	·6	0·324261	3154·5	·6	0·498944	2633·0	·6	0·636476	1926·0
·7	0·128527	3440·0	·7	0·327412	3147·5	·7	0·501572	2622·5	·7	0·638395	1913·0
·8	0·131966	3437·0	·8	0·330556	3140·5	·8	0·504189	2611·5	·8	0·640302	1900·0
·9	0·135401	3434·0	·9	0·333693	3134·0	·9	0·506795	2601·0	·9	0·642195	1887·0
4·0	0·138834	3431·5	10·0	0·336824	3127·0	16·0	0·509391	2590·5	22·0	0·644076	1874·5
·1	0·142264	3428·5	·1	0·339947	3119·5	·1	0·511976	2580·0	·1	0·645944	1861·0
·2	0·145691	3425·5	·2	0·343063	3112·5	·2	0·514551	2569·5	·2	0·647798	1847·5
·3	0·149115	3422·0	·3	0·346172	3105·0	·3	0·517115	2558·5	·3	0·649639	1834·5
·4	0·152535	3418·5	·4	0·349273	3097·5	·4	0·519668	2547·5	·4	0·651467	1821·5
·5	0·155952	3415·5	·5	0·352367	3090·5	·5	0·522210	2537·0	·5	0·653282	1808·0
·6	0·159366	3412·5	·6	0·355454	3083·0	·6	0·524742	2526·5	·6	0·655083	1794·5
·7	0·162777	3409·0	·7	0·358533	3075·0	·7	0·527263	2515·0	·7	0·656871	1781·5
·8	0·166184	3405·0	·8	0·361604	3067·5	·8	0·529772	2504·0	·8	0·658646	1768·5
·9	0·169587	3401·5	·9	0·364668	3060·0	·9	0·532271	2493·5	·9	0·660408	1755·0
5·0	0·172987	3398·0	11·0	0·367724	3052·0	17·0	0·534759	2482·5	23·0	0·662156	1741·5
·1	0·176383	3394·5	·1	0·370772	3044·5	·1	0·537236	2471·0	·1	0·663891	1728·0
·2	0·179776	3390·5	·2	0·373813	3037·0	·2	0·539701	2459·5	·2	0·665612	1714·5
·3	0·183164	3386·5	·3	0·376846	3029·0	·3	0·542155	2448·5	·3	0·667320	1701·1
·4	0·186549	3383·0	·4	0·379871	3021·0	·4	0·544598	2437·5	·4	0·669014	1687·5
·5	0·189930	3379·0	·5	0·382888	3012·5	·5	0·547030	2426·0	·5	0·670695	1674·5
·6	0·193307	3375·0	·6	0·385896	3004·5	·6	0·549450	2414·5	·6	0·672363	1661·0
·7	0·196680	3371·0	·7	0·388897	2996·5	·7	0·551859	2403·0	·7	0·674017	1647·0
·8	0·200049	3366·5	·8	0·391889	2988·0	·8	0·554256	2391·5	·8	0·675657	1633·5
·9	0·203413	3362·0	·9	0·394873	2979·5	·9	0·556642	2380·5	·9	0·677284	1620·0
6·0	0·206773	3358·0	12·0	0·397848	2971·0	18·0	0·559017	2369·0	24·0	0·678897	1606·0

Limits ϕ $0^\circ\ 0'\ 0''$ to $24^\circ\ 5'\ 41''\!\cdot\!4\ldots$

,, x/R 0·0 to 0·6804139...

Table II.

h/R	ϕ	$\omega\ F'(t)$	h/R	ϕ	$\omega\ F'(t)$
	° ′ ″	′ ″		° ′ ″	′ ″
0·0000	0 0 0·0		0·0051	10 35 21·3	+7 2·3
0·0001	1 24 1·4		0·0052	10 42 22·5	7 0·1
0·0002	1 59 18·3		0·0053	10 50 21·6	6 58·0
0·0003	2 26 14·4		0·0054	10 56 18·6	6 56·0
0·0004	2 49 2·5		0·0055	11 3 13·6	6 54·0
0·0005	3 9 10·6		0·0056	11 10 6·7	6 52·2
0·0006	3 27 25·6		0·0057	11 16 58·0	6 50·5
0·0007	3 44 15·9		0·0058	11 23 47·7	6 49·0
0·0008	3 59 58·8		0·0059	11 30 36·0	6 47·5
0·0009	4 14 47·0		0·0060	11 37 22·8	6 46·1
0·0010	4 28 49·8	+13 42·2	0·0061	11 44 8·2	6 44·7
0·0011	4 42 13·8	13 6·4	0·0062	11 50 52·2	6 43·4
0·0012	4 55 4·2	12 35·0	0·0063	11 57 35·1	6 42·3
0·0013	5 7 25·2	12 7·6	0·0064	12 4 16·8	6 41·2
0·0014	5 19 20·4	11 43·3	0·0065	12 10 57·5	6 40·2
0·0015	5 30 52·6	11 21·7	0·0066	12 17 37·2	6 39·2
0·0016	5 42 4·4	11 2·2	0·0067	12 24 16·0	6 38·3
0·0017	5 52 57·5	10 44·4	0·0068	12 30 53·9	6 37·5
0·0018	6 3 33·7	10 28·2	0·0069	12 37 31·1	6 36·8
0·0019	6 13 54·4	10 13·4	0·0070	12 44 7·6	6 36·2
0·0020	6 24 0·9	9 59·8	0·0071	12 50 43·6	6 35·7
0·0021	6 33 54·4	9 47·3	0·0072	12 57 19·0	6 35·2
0·0022	6 43 35·8	9 35·7	0·0073	13 3 54·0	6 34·8
0·0023	6 53 6·0	9 24·9	0·0074	13 10 28·6	6 34·4
0·0024	7 2 25·8	9 14·8	0·0075	13 17 2·9	6 34·1
0·0025	7 11 35·9	9 5·5	0·0076	13 23 36·9	6 33·8
0·0026	7 20 36·9	8 56·7	0·0077	13 30 10·8	6 33·8
0·0027	7 29 29·5	8 48·6	0·0078	13 36 44·6	6 33·8
0·0028	7 38 14·2	8 40·9	0·0079	13 43 18·4	6 33·8
0·0029	7 46 51·4	8 33·5	0·0080	13 49 52·3	6 33·9
0·0030	7 55 21·4	8 26·6	0·0081	13 56 26·2	6 34·0
0·0031	8 3 44·8	8 20·2	0·0082	14 3 0·4	6 34·4
0·0032	8 12 1·9	8 14·1	0·0083	14 9 35·0	6 34·7
0·0033	8 20 13·2	8 8·5	0·0084	14 16 9·9	6 35·1
0·0034	8 28 18·9	8 3·0	0·0085	14 22 45·2	6 35·5
0·0035	8 36 19·2	7 57·7	0·0086	14 29 20·9	6 36·0
0·0036	8 44 14·4	7 52·8	0·0087	14 35 57·3	6 36·7
0·0037	8 52 4·8	7 48·1	0·0088	14 42 34·4	6 37·5
0·0038	8 59 50·7	7 43·8	0·0089	14 49 12·3	6 38·3
0·0039	9 7 32·4	7 39·6	0·0090	14 55 51·0	6 39·1
0·0040	9 15 9·9	7 35·5	0·0091	15 2 30·6	6 40·1
0·0041	9 22 43·5	7 31·7	0·0092	15 9 11·3	6 41·2
0·0042	9 30 13·4	7 28·1	0·0093	15 15 53·1	6 42·4
0·0043	9 37 39·7	7 24·6	0·0094	15 22 36·1	6 43·6
0·0044	9 45 2·6	7 21·3	0·0095	15 29 20·4	6 45·0
0·0045	9 52 22·3	7 18·2	0·0096	15 36 6·1	6 46·5
0·0046	9 59 39·0	7 15·2	0·0097	15 43 53·4	6 48·1
0·0047	10 6 52·8	7 12·4	0·0098	15 49 42·3	6 49·8
0·0048	10 14 3·9	7 9·7	0·0099	15 56 33·0	6 51·6
0·0049	10 21 12·2	7 7·0	0·0100	16 3 25·6	6 53·5
0·0050	10 28 17·9	7 4·5	0·0101	16 10 20·1	6 55·6
0·0051	10 35 21·3	+ 7 2·3	0·0102	16 17 16·8	+6 57·9

Table II—*Continued.*

h/R	ϕ	$\omega\ F'(t)$	h/R	ϕ	$\omega\ F'(t)$
	° ′ ″	′ ″		° ′ ″	′ ″
0·0102	16 17 16·8	+6 57·9	0·0116	17 59 51·9	+7 48·8
0·0103	16 24 15·8	7 0·3	0·0117	18 7 43·5	7 54·5
0·0104	16 31 17·4	7 2·8	0·0118	18 15 41·1	8 0·6
0·0105	16 38 21·5	7 5·3	0·0119	18 23 44·9	8 7·2
0·0106	16 45 28·1	7 8·1	0·0120	18 31 55·6	8 14·3
0·0107	16 52 37·8	7 11·2	0·0121	18 40 13·7	8 22·0
0·0108	16 59 50·6	7 14·4	0·0122	18 48 39·8	8 30·2
0·0109	17 7 6·7	7 17·9	0·0123	18 57 14·3	8 39·1
0·0110	17 14 26·4	7 21·5	0·0124	19 5 58·2	8 48·8
0·0111	17 21 49·7	7 25·3	0·0125	19 14 52·2	8 59·4
0·0112	17 29 17·0	7 29·4	0·0126	19 23 57·3	9 11·1
0·0113	17 36 48·6	7 33·9	0·0127	19 33 14·7	9 23·9
0·0114	17 44 24·8	7 38·6	0·0128	19 42 45·6	9 38·1
0·0115	17 52 5·8	7 43·5	0·0129	19 52 31·5	9 53·9
0·0116	17 59 51·9	+7 48·8	0·0130	20 2 33·9	+10 11·4
0·01300	20 2 33·9	+2 2·2	0·01366	21 19 22·8	+2 44·7
0·01302	20 4 36·5	2 3·0	0·01368	21 22 8·6	2 47·0
0·01304	20 6 40·0	2 3·8	0·01370	21 24 56·8	2 49·4
0·01306	20 8 44·2	2 4·6	0·01372	21 27 47·5	2 51·9
0·01308	20 10 49·2	2 5·4	0·01374	21 30 40·7	2 54·6
0·01310	20 12 55·1	2 6·3	0·01376	21 33 36·7	2 57·5
0·01312	20 15 1·8	2 7·2	0·01378	21 36 35·8	3 0·5
0·01314	20 17 9·4	2 8·1	0·01380	21 39 38·0	3 3·6
0·01316	20 19 17·9	2 9·0	0·01382	21 42 43·1	3 7·0
0·01318	20 21 27·3	2 9·9	0·01384	21 45 52·0	3 10·7
0·01320	20 23 37·7	2 10·9	0·01386	21 49 4·5	3 14·5
0·01322	20 25 49·1	2 11·9	0·01388	21 52 21·1	3 18·6
0·01324	20 28 1·5	2 12·9	0·01390	21 55 41·8	3 23·0
0·01326	20 30 14·9	2 13·9	0·01392	21 59 7·2	3 27·9
0·01328	20 32 29·3	2 15·0	0·01394	22 2 37·7	3 33·1
0·01330	20 34 44·9	2 16·1	0·01396	22 6 13·3	3 38·6
0·01332	20 37 1·6	2 17·3	0·01398	22 9 54·9	3 44·8
0·01334	20 39 19·5	2 18·5	0·01400	22 13 42·8	3 51·7
0·01336	20 41 38·6	2 19·7	0·01402	22 17 38·3	3 59·3
0·01338	20 43 58·9	2 20·9	0·01404	22 21 41·3	4 7·3
0·01340	20 46 20·5	2 22·2	0·01406	22 25 52·8	4 16·8
0·01342	20 48 43·4	2 23·6	0·01408	22 30 14·9	4 27·6
0·01344	20 51 7·7	2 25·0	0·01410	22 34 47·9	4 39·8
0·01346	20 53 33·4	2 26·4	0·01412	22 39 34·4	4 53·4
0·01348	20 56 0·5	2 27·9	0·01414	22 44 35·6	5 10·0
0·01350	20 58 29·2	2 29·5	0·01416	22 49 55·6	5 30·1
0·01352	21 0 59·5	2 31·2	0·01418	22 55 37·5	5 55·1
0·01354	21 3 31·5	2 32·9	0·01420	23 1 48·2	+6 27·2
0·01356	21 6 5·3	2 34·7	0·01422	23 8 35·7	
0·01358	21 8 40·9	2 36·6	0·01424	23 16 15·2	
0·01360	21 11 18·4	2 38·5	0·01426	23 25 16·1	
0·01362	21 13 57·8	2 40·4	0·01428	23 36 50·5	
0·01364	21 16 39·2	2 42·5	0·01430	23 59 21·1	
0·01366	21 19 22·8	+2 44·7			

Limits h/R 0·0000 to 0·0143010...

THE PROBLEM OF THE GREAT AUSTRALIAN ARTESIAN BASIN.

By ALEX. L. DU TOIT, D.Sc., F.R.S.S.Afr.

(Communicated by Mr. J. E. CARNE.)

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I. Introduction.

By reason of its colossal size and extraordinarily economic importance, the Great Artesian Basin of Australia eclipses all others, and the interest therein is heightened by the exceptionally fascinating nature of the problems of its structure and mechanism.

For many years the obvious view that the basin owed its immense supply entirely to rainfall absorbed on its eastern and south-eastern margin, remained almost unquestioned, and it was not really until in 1906 Prof. Gregory[1] showed that many of the facts were irreconcilable with such a simple scheme, and that the meteoric theory was seriously challenged.

He concluded that a certain part at least of the water was of *magmatic origin*, some was probably *water included* in the sediments during their deposition, or was a *subsequent though ancient accumulation* from the atmosphere, and only the remainder was being drawn from the *present rainfall*, or that of very recent times, while in 1911[2] he went so far as to deny even the importance of the last-named action.

In 1912, Mr. Symmonds,[3] adducing many reasons backed up by chemical data and going even further than Gregory, concluded that the bulk of the water was "*juvenile*" or of *plutonic origin.*

Against such views Mr. Pittman,[4] until lately Government Geologist of N. S. Wales, the most uncompromising protagonist of the *meteoric theory*, vigorously protested,

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[1] J. W. Gregory, The Dead Heart of Australia, London, 1906.

[2] J. W. Gregory, The Flowing Wells of Central Australia, Journ. Roy. Geogr. Soc., Vol. xxxviii, 1911.

[3] R. S. Symmonds, Our Artesian Waters, Sydney, 1912.

[4] E. F. Pittman, Geol. Surv. N. S. Wales, especially, Problems of the Artesian Water Supply, etc., 1908; The Great Australian Artesian Basin, 1914; The Composition and Porosity of the Intake Beds, etc., 1915.

claiming that all other geologists in Australia were at one with him in favour of a purely meteoric derivation of the waters in the Great Basin.

When in Australia in 1914, through the generous invitation of the Commonwealth Government, the author found that, so far from this being the case, quite a number of the local geologists were perfectly ready to admit that many aspects of the problem could better be explained by the rival hypothesis, and there seemed to be a fairly general opinion, that neither view alone would account for all the facts observed, and that further investigation of the problem was therefore highly desirable.

The papers by Gregory and Symmonds have certainly been of immense service in directing attention to this question, which is one so intimately bound up with the welfare of Australia, and it cannot be doubted that this novel presentation of the subject, has stimulated in a considerable degree scientific investigation of the Artesian Basin, which has borne fruit in the two valuable reports of the Interstate Conference (1912 and 1914); it is reassuring also to find that a number of contentions or suggestions by Gregory or Symmonds, originally received with somewhat violent opposition, have either been partially admitted or else recognised as being worthy of further research.

The Great Artesian Basin is perhaps the finest instance known of a geological problem to which the statistical method—the quantitative and final stage in geological investigation—can be applied, and, though the data published concerning the numerous bores are often incomplete in many important details, and uncertainties are constantly appearing, yet it is believed that enough material is available of sufficient accuracy to enable deductions to be drawn with a certain amount of precision. In the compilation of the accompanying maps, all available data have been con-

sidered and plotted, figures that appeared in any way doubtful having been omitted: for example, all shallow bores were excluded in considering temperature increments.

Though the writer's personal knowledge of the area is of the slightest, his interest in the problem, principally by reason of certain analogies with South Africa, must serve as an excuse for the contribution; moreover, the magnitude of some of the actions in dispute, such as the effect of gas, can be closely determined, the probable rates of flow through the water-bearing beds can be estimated roughly, while there are particular aspects of the question dependent upon pressure, temperature and salinity that deserve to be set out and indicated in detail.

The hydraulic departments of the several States concerned are clearly alive to the importance and urgency of the solution of the problem, especially in connection with control of the supplies now and in the future, but, as Mr. Knibbs pointed out in 1903,[1] our knowledge of the physics of the basin in its earlier and almost untouched condition is very slight. Now, though data are rapidly being collected, the equilibrium of the reservoir has been entirely upset, and this disturbance from the original condition is making the solution of the problem more and more difficult owing to the falling pressure in bores, to their mutual interference, and to leakage, with consequent reduction of yield. The potential surface is in a state of flux, the accurate determination of the isopotentials over the entire region for any particular short period is a practical impossibility; accordingly deductions drawn from their position and shift are likely to be only partially correct.

In utilising the published data for the preparation of the attached maps, it must be explained that considerable discrimination had to be used and much material rejected, by

[1] G. H. Knibbs, this Journal, XXXVII, p. 24 – 47.

reason of the incompleteness of the returns and the abridgement of details as regards strata cut, number of water-beds, their thickness, their yield, temperatures of the various flows, pressures, etc.; still it is believed that on the whole the graphic presentations are not far from the truth, except where the bores are scanty and far apart.

The excellent bibliography given by Pittman, makes it unnecessary to attach a list of the important papers on the problem; the reports of the Interstate Conferences are referred to as I and II for convenience.

II. The Physiography of the Basin.

While valuable accounts have been written by Jack, David, Pittman, Cameron and others, there has curiously enough been no comprehensive and detailed description of the entire basin, attention having naturally been concentrated more upon the problem of the origin of the water, and unfortunately, it is precisely in regard to certain important and even vital points that data are particularly lacking.

One of these is concerned with the nature of the sub-surface contour of the great hollow, about 1,200 miles long and 700 or 800 wide, filled in with Mesozoic beds, resting upon a compact basement of Palæozoic and older sediments, granites and other igneous rocks. For the New South Wales portion, a good idea can be obtained by plotting from the records of such bores as are known to have bottomed on bed-rock (II. App. B.), assisted in places by those that have failed to reach the very base of the artesian beds. In Queensland, it is only occasionally that bores have struck the underlying foundation, an exception being the tract Y-shaped in plan, stretching northwards from Tooleybuck across the Northern Railway to Savannah Downs and to Canobie; the bores in this section are all shallow. There are also a few cases in the south between Cunnamulla and

Hungerford, and some isolated instances near Charleville, Longreach, Muckadilla, Darr River Downs and Normanton, and it is regrettable that they should be so few in number.

By utilising the figures given for the deeper and stronger flowing bores, a fair idea can be gathered of the form of the basin, or more correctly speaking, its shape at the base of the principal water-bearing zone, a result which will be of more real value after all, as will be seen later. On the attached map (I) the sub-contours obtained in this way are

Diagram I.—CONTOURS OVER FLOOR OF BASIN; figures in hundreds of feet below sea-level.

given in hundreds of feet below sea-level, following the plan adopted by Cameron.[1]

Though the irregularity in relief of the floor, as shown by the outcrops of granite well within the basin, such as

[1] Ann. Progress Rept. Geol. Surv., Qu ensland, 1900, p. 10.

those in the south at Eulo, Hungerford, near Angledool, between Walgett and Collarendabri (in which the bottom sinks to as much as 2,500 feet not far away) and to the north of Warren, yet the bore records indicate that this topographic irregularity is probably not general, but confined to certain belts representing buried chains of hills[1] (See I, §1809).

The most important feature, and one to which attention had been drawn at an early date, is the broad bulge in the floor (with its surface rising almost to sea-level) athwart the narrowest part of the basin between Cloncurry and Saxby Downs. The view too, that the artesian water would have to well up from the deeper region to the south-east in order to travel across this buried "spill-way" into the section A, is obviously in part correct; the supplies are all shallow hereabouts, while the floor drops to the north-west, and is cut in the Normanton bore at a little over 2,000 feet below sea-level. Opinion supports Jack's view of a considerable submarine leakage of artesian water in this quarter into the Gulf of Carpentaria.

The next is the buried low ridge extending south-westwards from Charleville by way of Cunnamulla to Hungerford, and thence directed south-eastwards to Bourke and Brewarrina; at over half a dozen localities, indeed, does granite appear at the surface (See II, pl. 29). This ridge cuts the basin into two unequal parts, the lesser of which, C, sinks to below 3,000 feet beneath sea-level on the New South Wales-Queensland border, while primary rocks were reported at 2,600 feet below sea-level on its southern margin at Muckadilla; the depth of its base on the east below the Darling Downs is indeterminate, however, and

[1] Several typical sections are included in the Queensland Hydraulic Engineer's Reports for 1892 and 1895, also by David, in the Federal Handbook, B.A.A.S., 1914; and by Pittman in the Mineral Resources of N. S. Wales, 1901.

the geological structure in this quarter will be referred to later.

The main portion B of the basin deepens rapidly to the south-west of Longreach, and the floor goes down to nearly 4,500 feet below sea-level around Bimerah. The region westwards is as yet unprobed, and the floor may in points descend to depths of well over a mile; in South Australia the deep bores at Mount Gason and Goyder's Lagoon have not struck bed rock, although the bottom of the last named is over 4,700 feet below sea-level. Along the margin hereabouts, the now buried land surface was one with considerable topographical irregularity, and this unevenness seems to have been aggravated by Tertiary faulting, as at Warrina.

Owing to the scarcity of bores within this huge western region, the shape of the floor is almost unknown, but to the north of Broken Hill there are long partially exposed ridges of palæozoics, forming the Stokes and Grey Ranges, stretching away into Queensland to the neighbourhood of Thargomindah, and only by means of boring can it be proved whether perhaps this sub-surface feature continues north-westwards. It may well be that the western portion D is only imperfectly connected with B, in the same way that B is linked to E. Some further remarks concerning these ridges will be made in treating of the Tertiary History of the Basin (Section IX).

The widespread covering of superficial deposits conceals to a large extent the boundary between the lower-lying Mesozoic infilling and the marginal rim of older rocks, so that the delimitation of the basin has presented many difficulties, more particularly along its southern side.

In South Australia, Ward has concluded (I. §§ 47–51, 93, 166–204) that the west-south-western boundary of the basin follows more or less closely the line of railway, with

some extension to the west of Oodnadatta;[1] maybe there are one or more limited outlets leading westwards into the Eucla Artesian Basin, following limited channels in the older rocks, and towards which the Mound Springs near Lake Phillipson point. This is, however, only just a possibility, but against it there is the extreme contrast in chemical composition shown by the two classes of waters (See II. p. 269) as will be emphasized in Section V.

On the south the basin is cut off from Spencer's Gulf by a barrier of ancient rocks, and from the Murray Tertiary Basin, both near Lake Frome and between Cobar and Bourke by buried ridges. Pittman, while raising the point whether there might not be an overflow close to Wilcannia below the Cretaceous beds into the younger basin, considers that the evidence in its favour is very slight (I. § 86, 1911).

III. The Geology of the Basin.

The recent work done by Saint-Smith (II. p. 19) in the area north of Roma, in definitely proving that the actual intake beds consist of the fresh-water strata underlying the marine Lower Cretaceous Rolling Downs formation, of which the so-called "Blythesdale Braystones" really form the basal portion, at once brings the Queensland succession into line with that in New South Wales, as worked out by Pittman during the last twenty years.

In view of their stratigraphical and palæobotanical relationships, the use of the term Trias-Jura—a relic of ancient nomenclature—is cumbersome and not altogether desirable, and for these reasons the name "Jurassic Beds" is to be preferred, as employed by Gregory and David, with the proviso that in certain localities some actual Rhaetic or even Triassic strata may be involved, as perhaps in the south-eastern corner, where there may in places be a conformable passage downwards into Palæozoic rocks.

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[1] See R. Lockhart Jack, Geol. Surv. S. Aust., Bull. 5, pt. 2, 1915.

The position as regards the "Intake Beds" in Queensland now stands in a rather uncertain state; large areas of so-called "Desert Sandstone" have been eliminated from the map and the Blythesdale Braystones are being grouped with the Rolling Downs series. For these reasons no attempt has been made to delimit the artesian series on the accompanying maps, the necessity for the omission being greatly regretted.

The important corollary that the Jurassic beds on the *north-eastern* side of the Great Dividing Range must also act as "intakes," would apply to a limited degree only in the Dawson River catchment, as can readily be seen from Saint-Smith's section (II. pl. 25), the right hand half of which obviously cannot be contributing anything to the supplies struck at Roma or Wallumbilla for instance; further to the north, however, their quota may be much more considerable. However this may be, of paramount importance is the conclusion that these porous Jurassic sandstones crop out along the flanks and even along the crest of the main watershed, for it may be presumed that the bulk, if not the whole, of the "Desert Sandstone" (still called by that name on the latest geological map) between Roma and Hughenden will prove to be really the freshwater Jurassic Series. They must be the same strata extending north-westwards past Croydon, described by Gibb Maitland,[1] under the name of "Blythesdale beds."

At Hughenden their dip is a little steeper and the outcrop narrower, while their base rests on granite or schists at an altitude of just over 2,000 feet above sea-level at Mount Miller, falling to about 1,800 feet along the railway, and dropping to about the same level in Betts' Gorge Creek to the north, where the beds are found in ravines that have been cut through a great capping of younger basalt.

[1] A. Gibb Maitland, The Delimitation of the Artesian Water Area North of Hughenden, Geol. Surv. Queensland, 1898.

Except for the two gaps through which the Northern and Central railways have been run, the watershed seems to attain an altitude of from 2,000 to 2,500 feet, quite sufficient to account for the pressures met with in the bores out to the west.

South-eastwards from Roma, the Jurassics form a broad belt curving past Dalby and Toowoomba to the New South Wales border, where they rest upon palæozoic rocks, etc., and have a considerable development east of Moree, extending from Narrabri to Dubbo, where their outcrop comes to an end.

Pittman's recognition of *Tœniopteris Daintreei*[1] in certain wells and in the Moree, Coonamble, Nyngan, Wallon and Bulyeroi bores, indicates the presence of the Jurassics beneath the Cretaceous cover over a large region, considerably extended by a similar discovery at Salisbury Downs far to the west (north of Wilcannia). Excepting by David,[2] there seems to be a reluctance on the part of geologists to admit that these fresh-water beds have any great sub-Cretaceous extension in Queensland, and that they form the real Artesian Series there. Yet quite a number of bores in this State derive their water from a series of sandstones and shales with coal-seams underlying the marine blue shales, not only along the eastern margin (Muttaburra-Blackall-Roma), but well out within the basin, *e.g*,, Kynuna and the deep bores at Elderslie and Bimerah, and at Canobie well to the north of Cloncurry.

Whether these beds actually extend across to the west and south-west, is an important question upon which very

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[1] Mr. Pittman's announcement was made in 1895. Annual Report Department of Mines, New South Wales, p. 123. In 1891 Mr. Robert Etheridge identified *Tœniopteris* in strata pierced by the Nyngan (subsequently proved) sub-artesian bore. Annual Report, Department of Mines for 1891, p. 320.—Eds.

[2] Federal Handbook, B.A.A.S., p. 280.

little has been said, but it seems not unlikely that there is a general thinning out of the Jurassics in those directions, and that to the east, on the contrary, still lower zones are involved equivalent to the Lower Jurassic, Rhætic and even the Upper Triassic without any unconformity, deposition having commenced in the east and the area of sedimentation having gradually extended westwards. An overlap like this, such as might only be expected in view of the huge area covered, is indicated by the zones present between Toowoomba and the sea-coast, which include horizons certainly lower than the artesian beds proper, or the Walloon Series on the top of the plateau; such a transgression is in fact shown in Cameron's section through Cloncurry and Hughenden.

This relationship would be reflected in the position of the water bearing zones relatively to the base of the Artesian series, and it is significant that away from the margin the former are commonly situated not far above the base of the group (See II. pls. 16 – 21), but closer to the "intakes" there are considerable thicknesses of non-productive strata below the main water-bearing horizon, as for example, in Greendale Resumption (Tambo), Muckadilla, Roma, and perhaps Nevertire near Warren. Indeed, under such conditions, it would be uneconomical, despite the value of the geological information obtainable, to sink the boreholes down to bed-rock, as has consistently been carried out in New South Wales during late years. Probably this condition holds over a great length of the eastern margin where the Jurassics or Jura-Trias rest with unconformity upon granite and palæozoic beds, *e.g.*, Dawson River.

Whether there may not also be a lateral change eastwards into less pervious sediments is not clear, but such a possibility would help to explain the failure of deep boring near Brisbane, for, in spite of Pittman's criticisms based

on the dip, etc. of the beds, there would seem, as Gregory has contended, to be quite a possibility that some of the rainfall on the Toowoomba Plateau should enter the strata wherever the covering of basalt is absent, and percolate downwards along lenticular sheets of sandstone, and thus make its way down to lower levels on the seaward side of the great escarpment.

Further to the south in New South Wales, where the Jurassics rest upon Permo-carboniferous and Triassic sandstones in certain places, it would be possible for some of the artesian water to have been derived from these older formations, more especially as they frequently outcrop on high ground to the east and possess a westerly dip below the Jurassics, *e.g.*, in the Nandewar and Warrumbungle Mountains. The artesian bore in the "coal-measures" at Ballimore near Dubbo is a valuable piece of evidence in this connection.

The variability in thickness and number of the water-bearing layers, with their accompanying impervious or semi-pervious shaly partings, is considerable (See II. pls. 16–20, and sections in the Ann. Reports of the Hydraulic Engineer, Q'land), as would only be expected in view of their mode of origin, and this seems to be rather marked on the north-western side of the basin. It might be remarked that it is just in this quarter, a little south of Oorindi Station on the Cloncurry railway that there is a local rise of potential against the sloping floor of palæozoic rocks.

Whether this indicates the proximity of a local intake is not clear, but, if so, this is the sole occurrence giving definite support to the view that water might be contributed from meteoric sources along the north-western edge of the basin.

H. Y. L. Brown has suggested, and L. K. Ward is in agreement, that in the area north of Charlotte Waters the sandstones and grits of the Goyder and Finke Rivers may act as intakes. This receives support, firstly from the much greater altitude of the region cited, and secondly from the fact that the waters of this marginal stretch are not of the sodic carbonate type, and thirdly from the observations of R. Lockhart Jack, that the potential surface west of Oodnadatta rises to the west and north. The rainfall on the other hand is extremely low (4 to 6 inches annually) and the evaporation high, but the precipitation may have been higher in the past (see Section XI).

That the waters possess greater static pressures as well as temperatures in the lower water-bearing zones, together usually with a lesser salinity, is a truism, and, that the supplies at different levels are in many cases quite independent of one another, can be proved by the constancy of flow between the double casings when the deeper supply is shut off, *e.g.*, Bando No. 3 and Congoola East (Offham No. 2) in Queensland.

Symmonds deserves credit for having pointed out the "short-circuiting" effect of slotting the casing opposite water-bearing beds having different pressures, a policy which would and probably does account for the rapid falling off of pressure and yield in such bores. The upper waters being more saline, should, if only for agricultural reasons, be prevented from mixing with the main supply.

While in many bores there is only one water-bearing stratum of importance, in others several are present, occasionally eight, ten, or even more, but of such cases reported from Queensland, the majority are mostly located near the margin of the basin, or on the shallow ridge separating the sections A and B.

These layers, varying in nature from extremely indurated types to incoherent "sand-rock," and consisting for the most part of quartz grains with a certain proportion of kaolinised felspar, exhibit great differences in their thicknesses at different points. The Conference's map (I. pl. 14) showing their value over part of New South Wales, gives figures ranging from 100 to over 700 feet, the lower values being coincident with the margin of this section of the basin. In Queensland there are similar changes from point to point, but the data published are not sufficient to establish any definite relationship of the above kind.

The water-bearing section of the strata is some 500—1000 feet or thereabouts, below the base of the marine blue shales, which may attain a thickness of several thousands of feet, and which form a practically impervious covering; in this connection it is unfortunate that so few sections of boreholes exceeding 2,000 feet have been published.

Towards the west and north-west, these porous beds seem on the whole to come closer to, if not actually to lie at, the very top of the Jurassic Series, and it is not at all unlikely that, with the development of an arenaceous marginal phase in the Cretaceous, such as would occur along the shelving floor of impervious rocks, the water-bearing beds of the east and centre, would by means of this overlap, be put into partial or complete communication with the Lower Cretaceous beds, and that the latter would then become the actual Artesian member. According to a remark of Carne,[1] this obtains in the north-western corner of New South Wales.

This relationship apparently holds in South Australia too, where perhaps the whole of the strata passed through in the deep boreholes is of Cretaceous age, though the Jurassic may be represented in certain localities and prob-

[1] Brit. Assoc. Handbook, N.S.W., p. 607, 1914.

ably exists at greater depths; this series is indeed well developed in the Leigh's Creek Artesian Basin[1] due south of Hergott.

To the west of Oodnadatta[2] the covering of blue shales gradually grows less, but the porous water beds are overlapped by the Upper Cretaceous series, or are concealed by superficial deposits in that direction; they seem to crop out to the north-west in the Northern Territory, however.

It is moreover precisely in those parts of the basin where such is the case, not only along the outer edge, but around inliers of older rocks as well, and at a few other points where the cover is thin, that the waters have burst out at the surface; such springs have unanimously been regarded in the light of safety-valves for the relief of hydraulic pressure. There is a chain of cold springs on the east, between Aramac and Richmond, but those across the shallow tract between Croydon and Cloncurry, and thence halfway round the periphery, past Hergott and at intervals to Bourke, are generally warm, having the same chemical composition as the waters of the Great Basin.

The annual outflow from the Mound Springs must be of no small magnitude, even without taking any account of the water that is escaping laterally into porous drifts, such as are met with in the upper levels of many of the bores, and that, though usually dry, somtimes provide small flows. The part played by the Mound Springs in the hydraulics of the basin will be considered later.

Considering the thousands of bores that have been sunk, the geological information recorded from them is remarkably meagre, and this is all the more regrettable, in view of the immense value of the data that could have been acquired systematicaliy during the past quarter of a century.

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[1] Brit. Assoc. Handbook, S.A., pp. 174 and 223-6, 1914.

[2] Geol. Surv. S. Australia, Bull. No. 5, 1915.

A great deal of knowledge concerning the strata could be obtained by the use (at intervals) of a specially designed cylindrical bit, so that from time to time fragments of the rocks passed through and of sufficient size for examination could be brought up; this method would be much more economical and rapid than the addition of a calyx attachment, and for most purposes nearly as effective.

IV. Temperature of the Waters.

(1.) *General.*

When it is considered that the rapid increases of temperature with depth within the Great Basin, are unequalled over the globe in any other region of undisturbed sedimentary rocks, unaffected by volcanic activity, it is perhaps remarkable, that, except by Jack, so little notice has been taken of this abnormal feature, for such it can be termed without fear of contradiction.

Even in Australia, outside the artesian basin, the rates are as low as proved by the few determinations that have been made:—Cremorne bore (1° F. in 80), Metropolitan Colliery (1° F. in 78 feet), Sydney Harbour Colliery (1° F. in 91 feet), Bendigo (1° F. in 80 feet), and Broken Hill (very low, perhaps 1° F. in 100 feet).

Some rapid gradients—to below 1° F. in 20 feet—have been noted from one corner of the Dakota Artesian Basin in the United States, but, as no satisfactory explanation thereof has been forthcoming, they cannot be cited in argument with conviction; on the contrary, a suspicion is raised that the conditions there may find some parallel in those in Australia.

In Western Australia the coastal artesian basins possess gradients steeper than the normal it is true, the values ranging generally from about 1° F. in 60 feet to 1° F. in 36 feet, but over huge areas in the Great Basin rates of increment of from 1° F. in 30 to 1° F. in 22, and occasionally steeper than 1° F. in 20 have been found.

The temperature found (180° F.) given for Nonda Downs No. I, beside the Northern Railway in Queensland, with a reputed large flow would, if correct, indicate a rate of 1° F. in 12 feet, in marked contrast to its neighbour (112° F., 1° F. in 34) at the railway station of that name. David[1] has also cited cases of rapid increases in this quarter, *e.g.*, at Toorak and Strathfield.

The variation in mean annual surface temperature is fully 14° F. across the basin from north to south, but the correction for altitude is fortunately small.

Diagram II.—Areal Distribution of Temperature Gradients; figures represent values in feet per degree F. (20+ indicates 1° F. for 20 - 29 feet; 30+, 1° F. for 30 - 39 feet, etc.).

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[1] Proc. Roy. Soc. N.S. Wales, Vol. xxvii, p. 423, 1893.

In regard to the figures computed from the bore records, some are certainly not quite exact, since the depth to the principal water-bearing stratum is not always exactly known, or there may be a mixing of the main flow with cooler water from a higher horizon. All figures from very shallow bores, and also any particularly discordant numbers, have been excluded, but at the same time it is only fair to point out that the curves obtained (see Diagram II) from the evaluations cannot be "smoothed down" unduly, since it is precisely towards the detection of such thermal irregularities that the analysis is being directed.

In addition to the *mean temperature gradient* calculated in this way, there is also the very interesting problem of the *change of temperature increment with depth*, but here the lack of the necessary data prevents more than a statement of the position as regards a few cases. Thus sometimes, where two or more flows have been struck, the respective gradients (measured downwards from the surface zone of constant annual temperature) are the same, for example, Darr River Downs No. 3 in Queensland; but there are cases in which the upper flow possesses a steeper gradient than the lower, as in Cunnamulla and Northampton Downs in Queensland, and in Beanbah No. 1, Bundy, Quambone Nos. 1 and 2, and Wingadee Nos. 2 and 4 in New South Wales.

In these the apparent rate of increase of earth temperature between the upper and lower flows ranges between 1° F. in 64 and 1° F. in 127 feet. Making the extreme assumption that the issuing water includes the whole of the upper supply (which, be it noted, actually possesses a lower static pressure) the theoretical temperature of the bottom supply can be calculated, but this computed inter-artesian gradient, though now steeper, is still far less rapid than the figures obtained for the upper flow in the instances quoted.

In strong contrast stands the bore at Normanton[1] in which at 2,002 feet a small supply was cut having a temperature of 104° F., whereas the main flow struck only 102 feet lower down possessed a temperature of no less than 151° F.; the granite floor was reached at 2,275 feet. At Mirra Mitta in South Australia, the temperature of the water increased from 122° F. to 176° F. between 3,485 and 3,506 feet, and to 190° F. at 3,534 feet. Gregory has quoted also the Kynuna well in which the temperature rose by steps concomitantly with each new flow, the figures increasing from 125° to 150° F. (25°) in the last 242 feet. Symmonds again has drawn attention to the remarkable increase in temperature (107° to 128° F.)—after its completion—in the Neargo bore in New South Wales, accompanied by a rise in pressure.

Still more curious is the deep bore at Winton, in which a limited supply with a temperature of 140° F. was cut at 3,235 feet, jumping to 182° F. at 3,555 feet; the main flow struck about 300 feet further down is stated to have had a temperature of only 173° F., and this has been maintained.

It is difficult to conceive, how, under the meteoric hypothesis, such extraordinarily rapid increases as those instanced, could first of all have been produced, and secondly maintained in strata through which the water is considered to be moving laterally with a low velocity, since convection currents, irregularities of flow and conduction, would always tend towards the reduction of such violent thermal gradients. Here we may introduce the question of the stability of a free body of warm water heated from below and compressed from above, but stationary, for, from the known coefficients of expansion, compression and density, it can be calculated that, with a more rapid temperature gradient than 1° F. in $5\frac{1}{4}$ feet, equilibrium is rendered impossible.

[1] Ann. Rept. Hydraulic Engineer, Queensland for 1896, p. 6 and sec. 9.

One can only conclude that these bores have been sunk very close to the points of location of hot sub-surface springs.

In considering now the *areal variation* in increment—apart altogether from the question of the abnormally steep rate nearly everywhere—the modification introduced by the slope of the water stratum should be analysed, such as would be brought about when water in its upward or downward movement crosses the isogeotherms.

In descending, the water will be absorbing heat from the enclosing walls, and in ascending, the reverse will be true; owing to this fact therefore, and to the extremely low diffusivity coefficient of rock, the temperature of the water would lag slightly behind the normal geothermic value in the first case, and exceed it slightly in the second, the relative values of such amounts being dependent upon the velocity of flow principally. In the Mound Springs the water emerges, probably, without having lost an appreciable amount of its heat, but with the small rates of movement and slopes actually experienced within the basin, the difference between the temperature of the water-saturated horizon and the neighbouring part of the earth's crust, must be of a very small order, even after the lapse of great intervals of time.

This action may, sometimes, be quite appreciable, however, for upon comparing the Diags. I, II, and IV, the waters descending into the "deeps" about Winton and Bimerah, and again to the west of Bourke, are found to be relatively cooler than elsewhere; this is also conspicuous in the stretch from Barcaldine to near Dubbo, along which the marginal bores show increments as gradual as 1° F. in 70 feet, steepening progressively outwards.

More marked is this influence in the broad region across the basin, from Kynuna almost to Burke, with a gradient

below 1° F. in 30 feet, and often as steep as 1° F. in 20, since this abnormality may in part be due to effect of the advance of the waters upon the shelving floor towards the points of efflux constituting the Mound Springs.

Nevertheless, there are considerable discrepancies from such an *à priori* reasoning, as in the case of the steep gradients about Richmond and Saxby Downs, and the patch along the presumed "intake" due east of Muttaburra. Several abnormal tracts are also found in the south, one of steep gradient at Warren, and particularly one of uncommonly flat gradient (1° F. in 70 feet) due west of Walgett; the way in which they run in belts (extending roughly N.–W.) would be rather puzzling to explain upon the meteoric hypothesis, after comparing the three diagrams and noticing the rather regular character of the underground flow hereabouts.

In seeking an explanation for the steep gradients observable, several possible factors can be discarded as ineffective —for example radio-activity—while the existence of reservoirs of petroleum can hardly be invoked. To some extent the low thermal conductivity of the great cover of overlying Cretaceous shales, and generally dry sandy drifts might have been responsible, aided by the presence of occasional coal-seams, and by the fact that the water-horizons would possess a higher thermal conductivity, while, had the basin formerly possessed a thick capping of Tertiary beds, a blanketing effect would thereby have been introduced, that, even after subsequent denudation of the region, might not yet have vanished.

Since the basement rocks are no different to those without the basin, and are no more conductive therefore, and since the strata are not situated in a region of extensive crustal folding, we are forced back to the only reasonable and at the same time adequate hypothesis, namely that of

the presence below the basin of an extensive mass, or more probably a series of masses of igneous matter introduced into that position in late Tertiary times (see Sec. X).

Koenigsberger and Mühlberg[1] in their analysis of the causes of variation in geothermic gradient have shown that values of from 27 to 21 feet per degree Fahrenheit are found only in regions that have been subjected to volcanic action in late geological times. That many thousands of years would have had to elapse before the thermal additions of this nature became dissipated, can indeed be shown by the calculations of Ingersoll and Zobell upon the rate of cooling of laccolitic intrusions.

(2.) *Secular Changes in Temperature.*

In such bores as have been re-examined after the lapse of some years, differences in temperature have not infrequently been observed; these are about as commonly positive as negative. The values range from 1 to a maximum of 9 degrees, but, when differences of a half or a whole degree appear, such are probably generally due to instrumental or other errors.

For the purpose of investigating this problem, the differences between the figures given in the two Interstate Reports, and corresponding to intervals of at least two years, therefore, were plotted for part of the New South Wales basin.

The analysis shows a fall of from 1° to 4° F. over the greater part of this area, but Carinda and Warren have rises of 6½° and 9° F. respectively, while a little to the north and to the west of Moree there are areas exhibiting increases of from 1° to 8° F. In the same district there appear the following contrasts in bores, the individuals of each pair of which adjoin one another, are down to bed-

[1] Trans. Ins. M.E., Vol. xxxix, pt. 4. especially table 4, 1910.

rock at nearly similar depths, and furnish an approximately similar yield:—Tycannah (Govt.) (–7°), and Tycannah (Priv.) (+2°); Bunna Bunna (–7°), and Bulyeroi (+5°); Midkin No. 3 (–8°) and Talmoi (+8°), differences amounting to 9°, 12° and 16° respectively—the last remarkable indeed!

To the west of Bourke the bores Wanaaring, Cuttaburra, and Kelly's Camp, have increased 8°, 9° and 10° respectively, while the deep Elderslie No. 2 bore in Queensland has risen from 202° to 211° F. Symmonds has noted considerable fluctuations in the temperatures of the bores at Neargo and Dolgelly in New South Wales.

A fall of temperature could easily be brought about by reduction in pressure, whereby water from a higher and cooler stratum would be allowed to enter. The slotting of the casing above the main horizon, so usual in the Coonamble district, will therefore explain the general drop in that region.

Neither the regular movement of water from regions of greater depth and therefore of higher temperature will serve to explain the departure noted in the Moree district, since, instead of neighbouring bores being affected in the same manner, the changes are frequently of opposite sign, and this is so, irrespective of whether the bores are down to bed-rock or not.

Though difficult of interpretation according to the meteoric hypothesis, such thermal abnormalities can readily be explained as having arisen through the contributing of of juvenile waters to the reservoir, an action that would be furthered by reduction of the static head of the bores concerned.

On this point further investigations are greatly to be desired.

V. The Salinity of the Waters.

Sufficient stress has not been laid upon the peculiar fact that the suite of waters in the Basin belongs to that rare class with predominant sodic carbonate and possessing therefore high "*primary alkalinity.*" Alkaline carbonate waters are distinctly uncommon among sedimentary types, one good example being those of Montreal;[1] the analyses from the last are closely comparable with those of Australia, but in certain localities, sulphates of sodium and of lime take the place of much of the sodic carbonate. Of the waters of the Texas Cretaceous basin,[2] with which an analogy has been expressed, only two are really comparable, since in those that carry sodic carbonate, this salt is subordinate to sodic chloride, and, when in excess, is accompanied by sulphates of sodium, lime and magnesium.

The suite of the Great Basin differs again most markedly from all the other artesian basins in Australia—palæozoic, mesozoic and tertiary—in possessing only rather minute quantities of calcium and magnesium carbonates, a general absence of sulphates, and, conspicuously, a distinctly low proportion of sodic (and occasionally potassic) chloride. In the other basins the amount of sodic chloride is usually five or six times as high—very much more so indeed in the Murray Tertiary Basin—carbonates of lime and magnesium are somewhat higher, especially in the Adelaide Plains Artesian Slope, and also chlorides and sulphates of Mg or of Ca; sodic carbonate is only present now and then, and invariably in small quantity.

Gregory pointed out that upon the meteoric hypothesis the salinity should increase in a more or less definite manner in a westerly or south-westerly direction from the assumed intake, inasmuch as soluble matters would be

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[1] Cumming, Geol. Sur. Canada, Mem. 72, 1915.

[2] R. T. Hill, U.S.G.S., 21st Ann. Rept., Vol. 7, 448 - 450, 1901.

taken up by the waters in the course of their progress across the Basin. In Wisconsin, Weidman and Schultz[1] have shown in the clearest manner how the waters are soft throughout the intake area in the central part of the State, but become more and more saline as they progress through the Cambrian reservoir to deeper levels in the south-eastern, southern, and south-western parts of Wisconsin, while after passing into Iowa,[2] this increase of salinity, with distance from the intake, has been found to have become still more pronounced. The distances involved range from 200 to fully 350 miles.

Gregory's map[3] only too well shows that the actual departure from *à priori* expectation is striking, since an area of relatively high salinity is present with Longreach at its centre; there is a second one about Cunnamulla, and only between Richmond and Cloncurry is the anticipation of progressive increase outwards fulfilled.

Symmonds[4] has rendered great service by proving that in almost every case examined in New South Wales, there is in individual bores a marked decrease in salinity with depth, the smaller upper flows being nearly always more mineralised than the main supplies tapped close to the floor of the Basin; concurrently, there is a small increase in potash and lime. He was also led to conclude that the supplies towards the intake were in many instances more saline than those met with further out.

Both Gregory and Symmonds lay stress, and rightly too, upon the excessively low amounts of sodic chloride present in the bulk of the deep waters—in some cases reaching only two grains per gallon, a quantity far lower even than

[1] Wisconsin Geol. and Nat. Hist. Survey, Bull. 35, ch. 7, 1915.

[2] Iowa, Geol. Surv., vol. 21, p. 205, and pl. iv., 1912.

[3] J. W. Gregory, The Dead Heart of Australia, p. 312 and map, 1906.

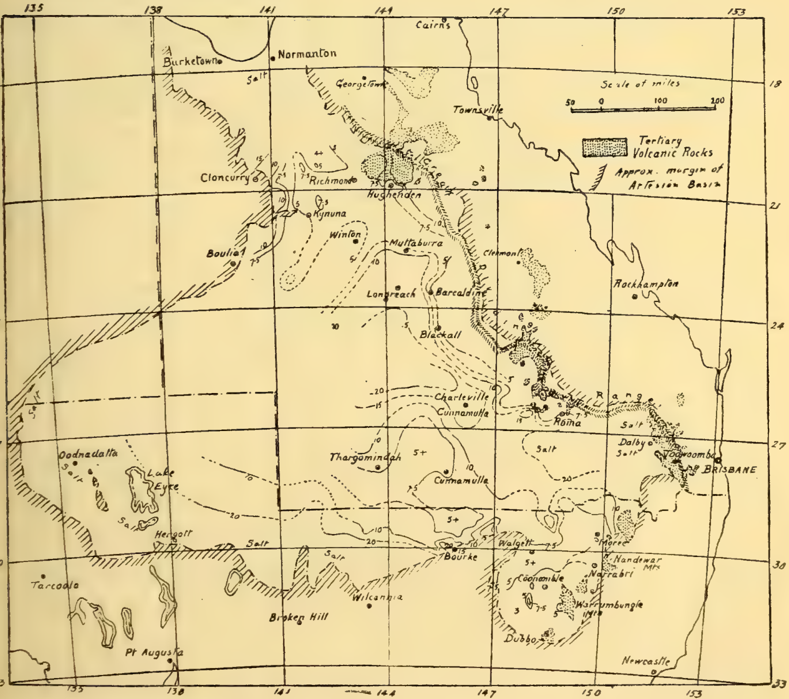
[4] R. S. Symmonds, Our Artesian Waters, p. 22, 1912.

in many of the river waters of Queensland (see analyses in I. App. pp. 52 - 63).

In the preparation of the accompanying Isosaline Map (Diagram II), only the amount of chlorides present (with rare exceptions wholly that of sodium) was chosen for plotting, for the following reasons:—

(*a*) because of the fact that as yet the abstraction of common salt from percolating water is unknown to occur in nature under the conditions normally met with here, (*b*) because its proportion therefore can only be increased and not diminished in time, and by the movement of the water, and (*c*) because on the other hand the abstraction or conversion of carbonates is both possible and probable.

Diagram III.—Salinity of Waters; figures represent grains of sodium chloride per imperial gallon.



The map has been plotted to show grains per gallon, and in compiling it the high values from certain shallow bores, as well as from some deeper ones, have been rejected, the inclusion of which would prejudice the meteoric aspect somewhat. The lines of equal salinity should be considered in relation to the movement of the water as inferred from the courses of the isopotentials (see Diagram IV). It might be observed also that, when the amounts of sodic carbonate were plotted in a similar manner, there was generally more uniformity exhibited in regard to the quantities dissolved and their distribution.

The conclusions from the variation in the chlorine content are as follows:—The water entering at the high

Diagram IV.—Isopotentials for 1912; the figures represent hundreds of feet above sea-level.

potential region near Hughenden is distinctly saline, using that term in a purely relative sense, but its salinity becomes *less* further to the west and north-west; near the opposite side of the basin the proportion of common salt rises again. Data concerning the Flinders Valley are scanty, but at Inverleigh and at Normanton, the waters (in the latter case just above bed-rock) are very high both in chlorine and total solids.

Analyses are not numerous south of Hughenden, but from Aramac south-eastwards to Roma, the arrangement seems to be that the waters to the north-east or intake side are fresh, and that the salinity rises towards the south-west. Though the supplies at Barcaldine and Blackall contain only traces of chlorides, they are nevertheless high in alkaline carbonates. The water from the deep bore at Warbreccan is high in total solids, while that from Bimerah No. 3 is said to be "highly mineralised."

Around Chinchilla and Dalby the content both of carbonate and chloride of sodium is very high, and similar conditions are found away out in the Basin to beyond St. George. Low chlorine values exist about Moree, and the common salt content falls to 5 grains around Coonamble, the proportion of sodic carbonate ranging from 30 to 45 grains. It is close to Coonamble, and more especially on its south-western side, where the purest waters have been brought to the surface, often with only 2 grains of chlorides and 20 to 30 of alkaline carbonates; yet isolated within this region of "fresh water" is a small tract with about 9 and 40 – 45 grains respectively. Furthermore, cut off on the north, east and south by moderately saline water, extends a great tract between Cunnamulla and Thargomindah with a chlorine content of under 5 grains per gallon.

South of the route from Bourke to Milparinka and probably continuous westwards into South Australia, there

stretches a belt of water with over 20 grains of common salt, becoming very saline indeed along the southern margin of the Basin, well seen for example between Hergott and Oodnadatta.

It is surprising indeed to find that, after travelling underground through sediments, a distance of almost 600 miles, as one has to suppose, the bore waters at Goyder's Lagoon and Mungeranie in South Australia, actually possess only 8·2 and 9·7 grains of NaCl respectively, a fact that is all the more remarkable, considering the extremely high temperatures and pressures prevailing in the depths of the reservoir hereabouts. That the hot but very dilute alkaline solutions have reacted to a limited extent upon the quartz and silicates, is nevertheless proved by the return of from 1 to over 3 grains of silicic acid and soluble silicates in the analyses of waters from some of the bores and hot springs.

Sulphates as a rule are either absent or present in very small amount, and this is worth remembering when comparisons are being made with artesian waters from other parts of the world, *e.g*,, Texas, Wisconsin and Iowa. In the Coonamble district sulphates are pretty well confined to an area within which corrosion of casing is rife; they are also found in Queensland at Roma (Govt.), Afton Downs and Murweh, but are in much larger quantity along the shallowing margin in South Australia in some bores and certain springs, *e.g*., Catt's and Sulphur Springs (I. p. 191; II. p. 268). The presence of sulphate of magnesium along with that of sodium points to the marine Cretaceous beds as their probable source, although, from the fact that the sulphate waters may be low in sodic carbonate and often contain free carbon dioxide, it is possible that part of the sulphate may have arisen through the oxidation of sulphide of iron, nodules of which are known to occur in the strata of that quarter of the Basin; yet it seems very unlikely,

that any of the oxygen originally dissolved could have escaped being used up long ere the waters reached this point.

The sodic carbonate over the Basin generally ranges between 20 and 60 grains per gallon, and with the exception of Eromanga No. 2 (121 grs.) and Normanton (160 grs.) the high values are all along its intake edge, *e.g.*, Barcaldine and Blackall (64–70), Dalby (67), Baroma (67), Tunderbrine No. 1 (125), and the bed-rock bore at Narrabri (671).

Suggestive indeed is the occurrence of waters of this class, both along the outer edge of the Basin—the Ballimore bore, east of Dubbo (196 alkaline bicarbonates) the Helidon Spa below Toowoomba (212 sodic carbonate, 3 sodic chloride)—or further afield, as at Maria Creek on the Central Railway (576 grains) with pulsations of carbon dioxide, and several hot springs north-east of Hughenden between Georgetown and Chillagoe, to be cited later.

Obviously the carbonates could only have been formed by the prolonged action upon soda-bearing minerals of carbon dioxide—of which the artesian waters contain on an average about 40 grains to the gallon (in the combined form).

Cummings, it may be noted, has given reasons for ascribing the sodic carbonate waters in the limestones of Montreal to the numerous bostonite dykes which are often directly associated with the supplies. Suess has discussed the hypogene nature of the mineral waters with free CO_2 along the borders of the Erzebirge, while Parkinson[1] has considered the soda deposits of Lake Magadi in B. E. Africa, as having been formed by the hot springs rising through the alkaline lavas, the water being regarded as of plutonic origin.

[1] Journ. Roy. Geol. Soc., vol. 44, p. 33, 1914.

Illuminating are Gautier's[1] experiments in which he obtained a solution containing silicate of soda (with a trace of borate it should be noted) by digesting powdered granite in warm water, while at the same time only a minute trace of the potash of the felspars was dissolved; in the presence of CO_2 at relatively low temperatures the sodic silicate was converted into carbonate. Long ago Daubrée had discoved that soluble compounds could be obtained by merely grinding felspar in water, and that this action was assisted by CO_2 but inhibited by NaCl.

The production of the sodic carbonate by the carbonation of felspars is thus quite feasible, and it remains therefore to investigate the circumstances under which such changes could have taken place.

The analyses[2] of typical intake sandstones prove these rocks to be rather poor in alkalies and alkaline earths, and to have the percentage of soda almost universally lower than that of potash. Since they, as well as the artesian sandstones cut in the bores, are all more or less kaolinic in character, and must have carried a fair amount of felspar originally, it is only reasonable to conclude that they had yielded up a certain proportion of their soda to the waters percolating through them. On the other hand it is most essential to observe the location along the eastern side of the basin of nearly all the highly alkaline waters, and that such are often high in chlorine also.

The great quantity of carbon dioxide present, far higher even than in the "highly carbonated" waters of Iowa for example, seems out of all proportion to the amount that would be derived from the atmosphere under any but the most abnormal of circumstances (see next section), and

[1] La Genèse des eaux thermales. Annales des Mines, IX, p. 316, 1906.

[2] E. F. Pittman, Problems, etc., p. 15, 1908; The Composition and Porosity of the Intake Beds, etc., p. 9, 1915.

partly for this, but for other reasons as well, it would seem not unlikely that from deep-seated sources have been contributed waters charged with carbonic acid and also sodic carbonate.

Gregory has laid stress upon the presence of small amounts of boric acid in quite a large proportion of the New South Wales waters, and this substance is probably more widely spread, only it has not been looked for. He has regarded this radicle as pointing towards a magmatic origin for the water, and certainly Pittman's contention, that its presence is not peculiar, because borates would be contained in salts derived from sea-water by evaporation, is ineffective, because the Jurassic beds are admittedly of fresh-water origin, a conclusion supported by the scarcity of such compounds as sulphates, chlorides and bromides of magnesium. In citing F. W. Clarke on the marine origin of the borates at Stassfurt, Pittman should also have quoted this authority's conclusion, that in a large number of instances boric acid is undoubtedly directly of volcanic origin; Clarke has also noticed that in such cases there is the frequent accompaniment of ammonia. Without wishing to attach undue weight to the presence of this base, which would naturally be in very small quantity, it ought not to be overlooked that a good number of Queensland and a few New South Wales bores have free, as distinguished from albuminoid ammonia, in noticeable amounts, for instance Normanton and Dillahlah No. 2.

VI. The Gases Contained in the Waters and their Origin.

Of the gases evolved from bores—methane, nitrogen, carbon dioxide, and occasionally a little oxygen—the first mentioned has been observed in a few cases, *e.g.*, Thurloo, Yowie, Baroma and Currumbah in New South Wales, in Coonanna and Yandama in South Australia, but it is in Queensland that inflammable gas is most frequent, *e.g.*,

Tara No. 3, Eromanga Nos. 1 and 2, Portland Downs, Ruthven Downs, Dagworth, and particularly Roma. Indeed evidence has been led to show that it is commonly tapped just before the water is struck.

The fact, as already noted, that carbonaceous matter is not unusual, and that coal seams have been intersected in quite a number of bores in this State, generally above the water, would explain the presence of methane; the huge evolution at Roma in the Mineral Company's well came from an horizon far below the water-bearing zone, and from its composition has been surmised as not improbably originating from an oil-sand.[1]

As regards the nitrogen, Symmonds' analyses show that it most frequently forms the sole constituent of the gas evolved in New South Wales; though not reported from the other States, it is doubtless represented there as well, for its presence would easily be overlooked. David,[2] though realising the high temperatures involved, suggests the derivation of the nitrogen by the action of anærobic bacteria on organic matter, such as lignite or coal.

The nitrogen discharged from the bores of the Kharga Oasis in Egypt has been considered by Beadnell[3] to be mainly of atmospheric origin, on account of the presence of a small amount of argon. The New South Wales cases have been regarded by Pittman and Fawsitt as analogous to the Egyptian, but their argument is inconclusive, when it is realised that in Gautier's experiments, to be cited below, argon accompanied the nitrogen in proportion of from 1/40th to 1/110th, along with a little helium at times. Moreover, there are many hot and deep seated springs from which N, Ar and He are being evolved, that have been

[1] Queensland Geol. Surv. Pub., 247, 1915.

[2] T. W. E. David, Handbook for Australia, B.A.A.S., p. 281, 1914.

[3] H. J. L. Beadnell, The Cairo Scientific Journal, No. 52, v, Jan. 1911.

regarded as being fed with "juvenile waters," for instance in the Pyrenees, Aix-la-Chapelle, Plombières, Vichy and Maizières; indeed the element helium, which is characteristic of many thermal springs, has been pretty generally taken to indicate a plutonic source of supply.

On the other hand, quite curious indeed is the discovery that the natural inflammable gas from the Upper Carboniferous gas-field of south-eastern Kansas,[1] contains with hardly an exception, some nitrogen and helium. The amount of the latter element is roughly proportional to the former, and an example from Dexter consisted of CH_4 14·85%, N 82·70%, and He 1·84%. In North Dakota[2] a huge blower of nearly pure nitrogen was struck in a shallow gas-field.

It would be of extreme scientific interest if complete analyses of the gases from the Great Basin could be made, including some taken from different levels in the same bore; from analogy the discovery of argon, helium and neon would seem not at all unlikely.

Free carbon dioxide characterises the waters in the Coonamble district of New South Wales, and has been incidentally noticed in Queensland as well, *e.g.*, Bando (Govt.), the Mount Browne Springs on the Flinders and the shallow bore on the Central Railway in the small Jurassic basin of Stanwell near Rockhampton.

The gas would readily be overlooked in the presence of methane or nitrogen, while under other circumstances its existence might remain unsuspected owing to its solubility; even at the high temperatures prevalent, a water could retain from 3/4ths to 1/6th of its volume of the gas at atmospheric pressure.

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[1] U.S.A. Geol. Surv. Mineral Resources, 1913, 1463.

[2] U.S.A. Geol. Surv. Mineral Resources, 1908, II, p. 343.

How large is the amount of carbon dioxide held combined is perhaps not fully realised. While the Ca and Mg salts are in the bi-carbonate form, that of Na is either normal or acid; from statements made by Mingaye and Symmonds it appears that in New South Wales at least, the bi-carbonate state is either closely or fully attained. Taking the general analysis of the waters, the combined CO_2 per gallon would range from a minimum of nearly 20 grains to a maximum of about 80, and the average water may be reckoned to carry about 40 grains, or nearly three tons per million gallons. When comparisons are made with river, ground or artesian water of undoubted meteoric origin, it will be found firstly, that carbonates are rarely present in such high proportions, or, if so, on a large scale, and secondly, that, when they do occur, they consist almost entirely of those of Ca and Mg, and that sodic chloride is invariably present in relatively high amount and frequently sulphates also.

As to the quantity of CO_2 that could be derived from the organic matter in the rocks through the action of free oxygen of atmospheric origin dissolved in the entering water, it can readily be shown from the known solubility of the latter gas, that, under the conditions obtaining over the intake area, this would amount to not more than from 4 to 5 grains per gallon at the most. That a little oxygen may be left unused in the process is shown by the rare occurrence of this element in a few of the bores in the Coonamble district.

Of considerable importance is the fact shown by Fawsitt and Symmonds, that in New South Wales—and probably this will be the case elsewhere—free CO_2 is confined to the lower levels of such bores as contain it, and this, as Symmonds has logically argued, points strongly to a subterranean source for some of the gas at least.

The general coincidence of the area of corrosion of bore-casing with that in which the waters carry free CO_2 (and O) is now well known, and it is therefore highly suggestive to find that the bores in which such destructive action is taking place are arranged upon a long arc stretching from Saxby Downs in Queensland, through Hughenden, Aramac, Charleville, Cunnamulla, to Coonamble in New South Wales; at either end corrosion is particularly active. Although only a small proportion of the bores along this line are affected, fresh cases are now coming to light, while it must be remembered that about Coonamble several of the bores were not troubled in this way until after deepening; also at Saxby Downs the deeper flows are corrosive.

Still mere depth alone along this arc, does not necessarily imply corrosive action, and the suggestion is thrown out of a concealed fracture in the artesian basement through which CO_3 has been, and perhaps is still being contributed at points along its length. At the head of the Flinders River to the north of Hughenden, the artesian beds are thrown down against the schists by a "pre-basalt" fault, striking south-east, so that the tectonic assumption made is not without warrant.

The work of Gautier[1] has shown that considerable volumes of gases can be obtained by the dry heating of granite and other igneous rocks, comprising in their order of abundance H, CO_2, CO, CH_4, NH_3, N and sometimes traces of H_2S, similar in fact to those evolved during the eruptions of Mount Pelée and Santorin; the N is accompanied by Ar. Suess has pointed out that in the case of gaseous emanations the evolution of chlorine comes to an end first, and that the CO_2 continues its escape longest. Water in the form of vapour would be driven out of rocks

[1] A. Gautier, Genesis of Thermal Waters, Econ. Geology Vol. I, p. 688, 1906.

by a sufficient rise in temperature and CO_2 would be evolved by the silication of limestones under the influence of igneous sills and batholithic intrusions.

Since, as will be shown later, there is strong evidence that large basic or sub-basic masses were injected in Tertiary times into the crust beneath the eastern part of the Australian Continent, a likely source from which the balance of the CO_2 and N over that derivable from the atmosphere is at once provided.

VII. The Rising of the Waters under Pressure.

Five main causes may act separately or in conjunction to produce the flows from the Basin, the third of which has not been considered worthy of citation hitherto:—

(1) Gas Pressure.

(2) Rock Pressure.

(3) Contrasts in density due to temperature differences.

(4) Hydraulic Pressure.

(5) Thermal Sub-surface Springs.

(1) *Gas Pressure.*—The influence of bubbles of gas in raising the water to the surface has been considered an important one by both Gregory and Symmonds, but this has not been conceded by the Interstate Conference, although the principle involved received recognition in their second report (II, p. 16).

The effect is directly calculable, and the results obtained for different conditions are submitted in Appendix A, from which it will be seen that the influence may be indeed considerable, though the circumstances in Australia do not appear to be such as to make it an important contributor towards outflow as far as we know, except in some isolated cases.

The problem is a variant of that involved in the air-lift pump (see Gibson, Hydraulics and its Application, London,

p. 671, etc.). Let v = velocity of flow produced by gas rising freely from the bottom of a bore in which water would stand normally flush with the top of the casing, a = ratio "volume of gas at atmospheric pressure to volume of water issuing at surface owing to levitation of the column," d = diameter of bore in feet, h = depth of bore in feet, and f = constant for frictional resistance, which in the case of fairly clean wrought-iron or steel pipe may be taken as ·00575.

From Table A 1, it is seen that even an extremely small amount of gas can give quite an appreciable flow, a 1/100th% of gas in a 6-inch bore 1000 feet deep, inducing a yield of 13,300 gallons per day; the total volume of gas set free in that time will be only 2·1 cubic feet.

A marked instance of a shallow bore—in which this effect would be most pronounced and recognisable—is Fort Constantine No. 1, Queensland, 620 feet to the water-bearing beds (1 § 269), giving off 40 cubic feet of methane per day. This quantity would account for 74,000 gallons out of a total of 111,620, or two-thirds of the actual flow. A special example is Westlands No. 2, Queensland, with the water-bearing beds at about 3,300 feet in depth; the gas set free, 40 cb. ft. per hour, is enough to give an outflow of 163,800 gallons, whereas the actual flow is only about 30,000. In view of the high static pressure (42—80 lbs.) the supply below must be restricted.

Considering some actual cases in New South Wales as given by Symmonds, the effects in Wangrawally, Polly Brewon No. 2, Kensington, Walgett and Wapweelah No. 4 are negligible. In Yarraldool only 20,000 gallons per day and in Wirrah, Four Posts and New Yarrawa from 100,000 to 150,000 can be accounted for out of over a million. The only one in which gas can play an important part is Pera No. 1, where its effect (as based upon a statement of Symmonds) can be estimated roughly at one-sixth of the yield.

There are a number of bores from which large volumes of gas have been evolved, *e.g.*, Dagworth, Tara No. 3 and Roma in Queensland, more especially that of the Mineral Oil Company, but in those at Roma, owing to the fact that the water and gas were brought to the surface separately, the effect of the latter upon the flow, and especially the consequence of the failure of the evolution cannot be determined.

This is unfortunate, because there is no doubt that even moderate volumes of gas are capable of raising large quantities of water and of thereby inducing static pressures of considerable magnitude. This is shown by Table A. 2, calculated from a more complicated formula derived from the one given before; the higher figures are rather uncertain.

As it happens, these tabulated values represent only the effect of gas rising freely in the bore, the supply of water at the bottom being assumed unlimited in amount, though under such pressure only as otherwise to stand in the pipe at the surface level of the orifice. If, as generally happens, the water and gas at the bottom are under a pressure greater than that simply due to the height of the column in the bore, this additional pressure will have to be added to that induced, given in the table.

Hence it can be deduced that discharges of gas at the rate of one or more cubic feet per second, are fully competent to account for many of the flows found in the Basin; it would be interesting, therefore, to have more observations made upon the proportion of gas to water in various bores, as it is a common accompaniment. Any evidence bearing upon the variation in yield of the water in relation to the increase or diminution of gas would be welcome, for upon this point little can be gathered.

Tara No. 3, Queensland, evolved a considerable amount of inflammable gas, but the water-level ultimately sank

below the top of the casing. Is gas still being evolved, and, if so, is it in lesser volume? Without a number of careful observations on this point, there would always be doubt whether the gas was falling off owing to reduction in the flow of the water or *vice versa.*

Irregularities of flow due to outbursts of gas have been noted in a few bores in Queensland, *e.g.*, Congoola Lease, Westlands No. 1, and Maria Creek, the latter being outside the Basin though.

(2) *Rock Pressure.*—Gregory[1] has claimed rock pressure as an agent in artesian flow, a point disputed entirely by Pittman.

With a stratum of coherent sandstone it is obvious that only when the pore-spaces suffer reduction in volume by some external or internal action, could additional compression be exerted upon their water content. This might be brought about by (*a*) earth movements, involving a reduction in pore-space, (*b*) shaking of the grains into positions involving closer packing, and (*c*) solution of the matrix and crumbling of the rock. Of these, (*a*) is zero, owing to absence of lateral compression since the Basin was filled, (*b*) may have been brought about by seismic shocks—(note King's[2] remarks anent the level of a well affected by the passing of a train)—and (*c*) may quite likely be due to the action of the hot alkaline waters upon the felspar grains and clayey matrix of the sandstones; observe that the waters in South Australia may carry solub'e silicates, while the quartz grains of the beds in the Goyder's Lagoon bore have been slightly corroded.

In this way a cellular porous rock could be formed that would squeeze down slightly under the weight of the cover,

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[1] Journ. Roy. Geogr. Soc., vol. 38, p. 175, 1911; Economic Geology, vol. 9, p. 768, 1914.

[2] U.S.G.S. 19th Ann. Rept., pt. II, p. 278, 1898.

so that considerable pressures could be brought to bear upon the enclosed water.

It must be clearly pointed out, however, that this state of affairs would be a purely local and impermanent feature; the superinduced pressure would force the water laterally into regions of lower potential, but, in view of the slow rates of motion as we shall see, it is quite likely that a state of abnormally high potential might prevail over a certain tract until such time as relief would have been afforded by diffusion. This would be indicated on the Iso-potential Map by the lowering of inclination or reversal in the slope of the potential surface over the centre of the limited region affected.

There are several localities within the Basin where such irregularities obtain, and it is noteworthy that immediately to the north-east of Kynuna, the bore specially instanced by Gregory, there lies a region of large flow and presumably of high potential. On the other hand the fact that successive supplies met with in bores almost invariably rise to correspondingly increasing heights is capable of explanation otherwise, either as being due to independent water-horizons, having different potentials by virtue of different heights of intake, or equally well as irregularly bedded deposits fed through upward leakage from a single stratum near the base of the artesian series. With the latter conception a rapid rise in temperature might be expected in going from the shallower to the deeper waters; this, as a matter of fact is particularly well marked at Kynuna, where the gradient near the bottom is about 1° F. in 10 feet.

These are all points worthy of further investigation; chemical analyses would be of additional assistance without doubt.

(3) *Contrasts in density due to temperature differences.* —For general purposes, the density of the waters has been

taken as unity, without introducing any notable errors into calculations. The ranges of temperature are so considerable, however, and the depths of the bores frequently so great, that it is worth while computing the amount by which the potential would be raised by reason of the contrast between the cooler water near the intake, and the warmer and lighter column in a bore several hundred miles further out.

Consider, therefore, a case in which water enters at 75° F., and descends to a depth of 4,500 feet, by that means acquiring a temperature of 200° F. Its density will gradually and nearly uniformly be reduced from 0·99732 to 0·9620, and its mean density will therefore be 0·97966. From this it can be shown that the static head of a bore 4,500 feet will have been raised by temperature alone no less than 80 feet. The effect due to salinity may be neglected.

The result will help to explain the rather high potentials to be found over the western end of the Basin in South Australia. Boring in the deep part of the Basin beyond Bimerah will be looked forward to with interest in this connection.

The suggestion made by Dr. Jack and Capt. Gipps that tangible increases in pressure would be brought about by actual expansion in volume due to rise in temperature suffers from the same limitations as that derived through rock pressure, as pointed out by Mr. G. H. Knibbs.

(4) *Hydraulic Pressure.*—That the principal cause of pressure is the greater altitude of the water-table on the eastern margin of the Basin, cannot be denied in view of the abundant and convincing data in support thereof, though opinion may differ as to the way in which this head has been developed.

It should be pointed out at this juncture that in the compilation of an isopotential map, one is confronted by a number of difficulties.

Firstly, it is clear that in almost every case the pressure of the supply has increased with depth until the impervious floor has been reached. In New South Wales a great proportion of the bores have been sunk to bed-rock, but in the other States, this is the exception, and for this reason the figures for the static pressures cannot, and do not, represent the truth, though in many cases no doubt they are certainly but little lower.

Secondly, the serious leakage brought about by closing down bores, has prevented the taking of further periodical gaugings satisfactorily in a number of cases.

Thirdly, many private bores have never been tested, either through lack of opportunity, or because of the risk involved. Some idea, however, can be gathered as to their static pressures, from their yield in relation to their depth and diameter of casing. The friction developed during the flow represents a loss of head that is very considerable in the deeper holes, as shown by Table B, and by its means a *minimum* value for the static head can be obtained; the latter will exceed this by an amount depending on the porosity of, and depth into the water-bearing beds as will be discussed later on.

Fourthly, the presence of gas, as proved already, may raise the pressure considerably.

Fifthly, the data published in the two Interstate Reports are frequently incomplete; figures for the pressures are given that range between two very different values—in such cases the mean has been taken—while no doubt there are some inaccuracies. In re-plotting the Coonamble-Moree area from the data given in the Second Report, totally different values were often found to those marked on the Isopotential Map (plates 13 and 14). It is not clear, whether in the preparation of the latter, any pressures not in harmony with those of the adjoining bores were ignored

and the curves smoothed off, but, if so, it should be emphasised that it is of the highest importance that every apparent discrepancy be fully investigated before being rejected, because one of the very few direct indications of the irruption of magmatic waters below the Basin, will be afforded by the presence at each such point of an area of higher potential entirely surrounded by a region of lower.

There are several high potential areas, the isolation of each of which appears sufficiently well defined, while there are a number also where the bores are not sufficiently close together to make it certain that the region of higher potential is not merely a lobe.

Sixthly, owing to the rapid fall of pressure that the bores are showing, there will always be discrepancies between the static pressures got, solely by reason of the different dates upon which such measurements had been made.

The Map attached has been compiled almost entirely from the records in the Report for 1912, and does not therefore profess to give much more than the general direction of the isopotential curves for about that year; it might be compared with that in the Report of the Hydraulic Engineer, Queensland for 1900, (App. Map A, No. 9).

Like the latter, it proves the existence of the two regions of exceptionally high potential, the first immediately to the east of Hughenden, and the second to the north-east of Charleville, the hydraulic surface just exceeding 1,450 feet on the Burenda Lease; it throws out a prolongation or lobe as far westwards as Thargomindah at least.

From Richmond there is a depression of the hydraulic surface towards the north-west and the potential falls right across almost to Cloncurry, where there is a small local area of high potential, just south of Oorindi railway station; this is rather a curious feature, but whether it arises

from a local intake, or is due to another cause is not clear. From Kynuna the gradient falls regularly towards the south-west (corroboration of this has been given by F. J. Calvert, II, pp. 175-7), but between Kynuna, Richmond and Winton, there extends a region that appears to have an abnormally high potential. Actual pressure readings are absent, but, from the large flows either measured or estimated on Quambeytook, Sesbania, Albion Downs, Dagworth Resumption, Hamilton Downs, etc., reduced to pressures by the aid of Table B, this seems to be a tract possessing potentials of from 800 to perhaps over 1000 feet; reliable measurements of pressures over this bit of country would be very welcome.

A curiosity again is the belt of low potential running down from the Dividing Range past Muttaburra to Bimerah, and its extremely low value in that excessively deep bore. In the S.E. the isopotentials indicate a fall of head towards the W.S.W. in the Moree district, aud towards the W. and even a little N. of W. around Coonamble. The static pressure originally recorded for Munna Munna (117 lbs.) gave a potential of from 100 to nearly 200 feet higher than the surrounding bores, a matter of extraordinary interest. A lesser patch of high potential is found about Trialgara near by, and a more important one at Goondablui on the State border. There is a peculiar curving tongue of low potential extending from Wilby Wilby to Bourke, while between it and Barringun there stands an isolated tract of high potential with Lila Springs at its centre.

Concerning the central part of the Basin, nothing seems to be known, but the existence of bores on the extreme west with potentials well above 500 feet, shows that, if this remote quarter does not form an out-lying and detached region, then there must be a long narrow tongue of high potential extending westwards from Thargomindah, along which the hydraulic gradient will be low.

A study of the isopotentials proves in the clearest manner the *present* direction of movement of the Artesian water and also shows that along a considerable length of "intake" on the east, the accession of waters, apart from the two centres, cannot be much, and again, that beyond a point a little to the north of Warren, no further feeding of the water-bearing series is taking place, so that neither from south nor west are any appreciable supplies being contributed. The map also indicates, as pointed out by Pittman, the error into which Gregory has fallen, when he states that the pressures upon the meteoric theory would be insufficient to bring the water to the surface at the several places that he specifies.

The evolution of the form and slope of the potential surface is so intimately bound up with the Tertiary history of the Basin that this will be reserved for discussion in the later sections.

(5) *Sub-surface Springs.*—Though certain evidence has already been presented in Section IV in favour of the above, the subject will not be pursued further here in view of the additional remarks to be made later. It will be sufficient to say that there are grounds for presuming that springs were or are active in feeding the reservoir from below, and that the waters they supplied or are supplying, were or are similar in chemical composition to, and their temperature either the same or somewhat higher than, those of the Basin.

VII. The Absorption and Transmission of Water.

(1) *Absorption.*—One of the principal arguments quoted in support of the meteoric theory is that the run-off of the Murray River is much greater than that of the Darling, though this has been denied by Gregory. For reasons that will appear later on, the author has to express a doubt whether this problem, to which appeal is being made, is

definite enough to enable practical use to be made of it, though the principle of absorption is not denied.

The figures quoted by Pittman[1] certainly show that the respective run-offs of the two rivers are very different, yet a closer examination of the data reveals certain discordances. The twofold table that he presents, supplies figures for the Darling, both at Wentworth and at Bourke for the years 1895 – 1903, and a comparison of the readings indicates that there must be large losses in the flow between these two points (outside the Basin) due to evaporation and soakage.

Secondly, the catchment of the Darling has a mean annual temperature of fully 6° F. higher than that of the Murray, while a relatively larger proportion of it lies within the region of lower rainfall, where presumably the mean humidity is less. Until the relative value of each of these factors can be more correctly gauged, the lower discharge of the Darling ought not to be presumed as wholly or even in part due to the absorption of head-water run-off by the intake beds.

Certainly the reasoning of Mr. L. A. B. Wade "that the losses by evaporation, absorption and other causes on the Darling catchment, exceed by more than three and a half times the losses on the Mildura (Murray) catchment" is fallacious. Actually the annual "total loss" on the Darling for the period 1891—1911 is 20·56 inches of rainfall (22·66 – 2·1) out of 22·66 or 91%, that of the Murray similarly is 64%; their ratio is therefore $1\frac{1}{2}$ to 1 nearly, but how far this inequality may be due primarily to absorption and not to evaporation is still left undecided.

That the rainfall could be rapidly absorbed by the porous sandstones with their overlying sandy soils along the eastern

[1] E. F. Pittman, The Great Australian Artesian Basin, pp. 8 – 12, 1914.

margin of the Basin cannot be doubted, for Jack has given a list of large water-courses in Queensland that lose water rapidly in their channels—to this Gregory's criticism no longer applies, as the strata over which they flow are probably all Jurassic and not Cretaceous—, Gibb Maitland has cited the Cambridge River, a tributary of the Flinders (I. §§ 116 – 8), while there is also the section of the Macquarie just below Dubbo.

Altogether, recollecting that the mean annual rainfall on the Main Dividing Range ranges from 22 to 30 inches along its length, there should be no reluctance in acknowledging the correctness of the view generally held, that meteoric water must be making its way at the present time below the Rolling Downs Series and thus feeding the reservoir.

(2) *Transmission of Water.*—Pittman having admitted Gregory's contention that the Blythesdale Braystones will not be porous enough to transmit large enough volumes of water underground, it now remains to submit the Jurassic sandstones to a critical examination as to their capabilities in this direction.

Pittman's determination of their average porosity as equalling 25% may even be accepted without demur, with the proviso that some of the sandstones of the lower zones in the east are not unlikely to be a good deal more compact. In view of the fact, however, that the water-bearing beds are in depth often very friable and in the state termed "sand rock," the higher figure of 30% has been adopted in the following calculations, as to the rate at which water will be transmitted under definite heads.

Through the kindness of Messrs. B. Dunstan, L. K. Ward and R. F. Jenkins, I have been enabled to examine hand-specimens of typical intake sandstones as well as drillings from a number of bores in each of the States.

A microscopical examination of the material indicated:—

1. That the water is found equally in very fine and in moderately coarse grained sandstones.
2. That the fine sandstones are rather even in texture, the mean diameter of the particles ranging from 0·15 to 0·2 millimetres.
3. That in the coarser sandstones, though there are grains up to 1 or 2 mm. in diameter, or even more, their relative proportion is low, the bulk of the rocks being composed of grains ranging from 0·2 to 0·4 mm. in size, while there are many smaller particles that help to fill up the larger pores, and hence bring down the average diameter appreciably.

Altogether, considering both fine and coarse varieties, the mean effective size of particles may be taken to possess a diameter of from 0·2 to 0·3 mm., especially if one takes into account that the grains are never well rounded, that there are always smaller angular fragments present, and that the particles are bound together by a certain, though perhaps sometimes negligible, amount of rather incoherent kaolinic cement.

The following formula for the transmission of water through a bed of sandstone is borrowed from Slichter:—[1]

$$q = \frac{pd^2 s}{\cdot 96\, \mu h B\, (1-m)}$$

where q equals the volume of water in cubic feet per minute, flowing through s square feet of sandstone of porosity m, and effective diameter of grain d (in millimetres), under a head of p feet of water through a horizontal distance of h feet; B represents a variable dependent upon the closeness of packing of the grains.

[1] C. S. Slichter, U.S. Geol. Surv., 19th Ann. Rept. pt. II, p. 322, 1899.

The flow, it will be observed, is inversely proportional to the viscosity μ, and, since the latter varies from ·0080 at 86° F. to ·0032 at 194° F., full allowance has to be made for this factor, in view of the high temperatures so universally met with.

From this formula the following table has been computed, to show *the effective rate of flow per square foot of rock in feet per annum, under a difference of head of one foot per mile*, for sandstones of different mean average diameter of grain, assuming a porosity of 30%. The "effective velocity" is not the actual speed of the water in the capillary passages, but the more convenient quotient of q by s, and with a constant hydraulic gradient is *independent* of the horizontal distance involved.

Diameter of Grain.	86° F.	104° F.	140° F.	194° F.	
0·20 mm.	1·90	2·31	3·03	4·76	*Feet per annum.*
0·25 mm.	2·98	3·61	5·07	7·45	
0·30 mm.	4·29	5·20	7·30	10·73	
0·35 mm.	5·84	7·07	9·93	14·60	
0·40 mm.	7·60	9·24	12·12	19·04	

Even allowing values several times these for the augmenting effect of joints and bedding planes, as shown by King's application of Slichter's formula, and reckoning a fall of potential of four to five feet per mile (such as is just attained along the margin of the Basin, more especially about Hughenden), it will be seen that the rate of flow may rise to *100 or 150 feet per annum* at the most.

This value would probably be maintained in the deeper parts of the reservoir, for the effect of the lower hydraulic gradient would be compensated for by the diminished viscosity; moreover actual boring operations have frequently proved the artesian beds to include some rather incoherent "sandrock."

From these figures there follow two conclusions of the highest importance:—

Firstly, *that none of the present rainfall over the intake will become available within the Basin, even along its margin, till after the lapse of centuries,* and

Secondly, *that, unless the underground supplies are being augmented by magmatic waters, only the stock at present within the reservoir can be drawn upon.*

Consequently, since renewal of the reservoir through purely meteoric contributions may not be counted upon in the near future, it behoves us to investigate more fully the alternative factor; this will be done later on.

That the permeability of the water-horizons must vary greatly from point to point will be inevitable, from the mode of deposition of the Jurassic sediments, but this property can be demonstrated in a more tangible way by an analysis of the frictional losses in bores during their discharge. The resistance to flow through the bore-casing may be very considerable, as shown by Table B, computed for clean wrought-iron or mild-steel pipes of five and six inches internal diameter. The co-efficient of friction has been taken as 0·00575, but, from Osborne Reynold's work on the effects of temperature upon flow, it is clear that the co-efficient should be smaller, except when the casing is rough and encrusted.

Having worked out a number of cases with the aid of his formula, it seems to me that for the majority of bores with temperatures ranging from 100° F. to 150° F. the values given in the table ought to be multiplied by about 0·9 and 0·8 respectively.

Since the frictional losses vary inversely as the *fifth* power of the diameter (for 5 and 6 inch casing as 2·49 : 1), it might be worthy of consideration whether some of the

excessive flows could not be throttled by finishing the last few hundred feet with a smaller bit, and employing at the same time a smaller-sized and less costly string of deep casing.

The calculated casing losses are lower than the static pressures by amounts representing those due to friction in the pores of the sandstone forming the bore-walls, for the velocity in the capillaries increases progressively on approaching the borehole.

When, after eliminating the loss in head due to the casing, the residuals are compared, the great differences even in bores possessing similar depths and yields become apparent, and in this direction there is scope for considerable investigation. Examining only a few instances, we find in the deeper bores of New South Wales high values in comparison with their outputs in Finger Post, Goondablui No. 4, and Mullawa, and the reverse entirely in Boomi, Euraba, Coubal and Tyreel.

Among Queensland bores an interesting point is the high static pressure of many of the shallow wells regarded from this standpoint, *e.g.*, on the Corinda Leases, Manfred Downs, Saxby Downs, Warenda Lease and the deep Eromanga bore.

Slichter's formula for the yield of a well is unsatisfactory to apply, in that the most important quantity—the limiting distance of interference of wells—is given the arbitrary value 600 feet, this being undoubtedly too low. It is clear anyway that the "permeability" of the strata vary much from point to point.

In order to determine whether this variation takes place according to any definite or orderly plan, the assumption was tentatively made that the porosity of the strata does not change abruptly from point to point, but in a gradual manner. The volume of water passing across a unit strip

of vertical plane through the Basin would then be proportional jointly to the thickness of the water-bearing beds and the hydraulic gradient at that point. Over the eastern part of New South Wales, using the latest published maps of the isopotentials, there were plotted firstly the hydraulic gradients represented by the reciprocals of the distances between adjoining contours, and secondly the resistance to flow which was reckoned as being inversely proportional to the thickness of the water-bearing beds. Lines of equal value, that will be referred to as A and B respectively, were drawn for each of these sets of quantities.

The following relationships emerged:—(*a*) along the rim of the Basin high values of A accompanied high values of B, (*b*) low values of A generally coincided with low values of B, (*c*) but elsewhere there was a marked discordance, and this was especially noticeable just north of Warren, at Kiameron, at Wingadee No. 4, and over a belt extending N., W. and S.W. of Carinda.

(3) *Interference of Bores.*—The actually observed cases of direct interference of bores are few in number. Oldham (II, p. 30) records a conspicuous case at Fremantle in West Australia, where the wells were about a quarter of a mile apart: in this instance there was an actual flow from one into the other. Jenkins (I, §1030) cites an instance in the Coonamble district, where the distance was about three miles. Here, however, the effect observed must have been solely that brought about by the hydro-dynamic impulse propagated through the water-filled beds, an action that with distance would be delayed and finally damped out, especially in the presence of small amounts of gas. There could have been no immediate bodily transference of water from the one hole to the other, as the rate of movement underground, as shown earlier, would have been quite low even under the increased gradients developed through closing or opening one of the bores.

There have been instances again in which new bores have caused either a diminution or cessation in yield in one or more of the adjoining wells, as about Longreach (II, §§ 2135–2147) and Saxby Downs (II, §2807).

An approximate solution of the interesting and practical problem of *the limiting radius of interference* of a group of bores can be obtained in the following way.

Firstly, assume that the wells are arranged at equal distances R apart, in a chain parallel to the isopotentials, and that the effective velocity of the underground flow is v, and the thickness of the water-bearing beds t. Slichter[1] taking the case of a stratum in which there is a regular flow in one direction, has worked out the plan of the lines of stream-flow when water is being removed by a single well, and it will be observed on examining his graphic presentation, that all the water is being drawn from between two limiting lines of flow which are at first parallel, and then converge, and close upon and around the bore; the water further to right and left escapes. The captured portion may be considered as entering with the normal velocity v upon an arc of radius r and centre a little beyond the bore, within which its speed increases rapidly, and it will be found that this sector subtends an angle of about 120°, and that r will about equal $R/2$.

The water withdrawn by the bore crosses a sector of a cylinder $\frac{2}{3}\pi \times \frac{R}{2}$ along the length of arc and t in height; let this equal Q.

$$\text{Then } Q = \frac{1}{3}\pi Rtv.$$

If Q = 1,000,000 gallons per day, t = 300 feet, and v = 150 feet per annum or about 0·4 feet per day, then R = 1,273 feet or almost *one-third of a mile.*

[1] C. S. Slichter, U.S.A. Geol. Surv. 19th Ann. Rept., pt. ii, pl. 17, 1899.

Hence, if the bores be this distance apart, they will capture the whole of the underflow. If there be n rows of holes uniformly spaced and geometrically arranged to the best advantage, then they will have to be $\frac{n^2}{3}$ miles apart in order that each one's yield of a million gallons daily might be maintained; if they cover a belt b miles in width, their distance apart R' will have to be $= \sqrt{3b}$ miles.

Hence, if $b = 75$ miles, $R' = 15$ miles, and if $b = 300$ miles, $R' = 30$ miles.

Of course, owing to the time taken for water to travel from one bore to the next, some years would have to elapse before interference would first become apparent.

In order to obtain some idea as to the actual rates of abstraction of water from the Basin, two areas A and B, each of 3,250 square miles in extent, were selected N.W. and S.W. respectively, of Moree, and such that, as far as possible (as indicated by the isopotentials), all the water reaching B should first have to pass through A. The results are displayed below:—

Area.	Number of bores in area.	Mean distance apart in miles.	Mean depth in feet.	Average thickness of water-beds in feet.	Mean difference of potential in feet per mile.	Total output in millions of gallons per day.	
						1912	1914
A	25	11·5	3470	450	2·7	18·5	16·6
B	36	9·5	2435	300	2·0	8·5	6·9

Assuming, as we have done before, a nearly constant permeability, the flows across equivalent breadths of country would be proportional both to the thickness of the water horizon and the hydraulic gradient, and the relative total yields might be expected to be roughly in the proportion of $\frac{450}{300} \times \frac{2·7}{2·0}$ or 2 : 1.

Actually in 1912 the ratio of A to B was 2·23 to 1, though two years later it was 2·4 : 1; nevertheless, since it can be

shown that the falling off of B would have been much higher had A been overdrawing the supply, one must conclude that interference is *not yet* marked, and that the falling off in yield is due rather to a universal lowering of potential over the region.

Calculations based on underground velocities of 4 and 6 inches per day, give the volume passing into A as between 30 and 40 millions daily, and that into B as from 16 to 20; although only approximations, these figures serve to give a general idea of the magnitude of the quantities involved, and fit well with the conclusion stated above. Upon tabulating the results within a square degree of country around Blackall in Queensland, similar conclusions were reached.

That the lowering of head is general rather than local is indicated by the fact, that the hydraulic gradient calculated from bores now sub-artesian but originally flowing, may correspond exactly with that obtained from the still flowing wells, for example at Winton (II, § 246); therefore the duplication of bores is generally no remedy for loss of head not due to leakage or obstruction.

The increases in yield of a few bores, *e.g.*, Neargo and Collymongle in the Moree district, are in strong contrast to the almost universal reduction as shown by the records of the several Hydraulic Departments, and which the Interstate Conference has found to be proceeding at a progressive rate—in New South Wales between 1903-8 at about $5\frac{1}{2}\%$ per annum, and for 1913-4 at about 8%—thus bearing out Gregory's[1] contention for the necessity of the restriction of flows by legislation or otherwise. In view of the importance of the recommendations made by the members of the Conference,[2] it is needless to say more, except to express a hope that they may be given effect to as soon as possible.

[1] J. W. Gregory, Journ. Roy. Geogr. Soc., Vol. 38, p. 38, 1911.

[2] II, pp. xii – xv.

IX. The early Tertiary History of the Basin.

It seems to have been tacitly assumed that the Basin has suffered but slight changes during the late Tertiary and Quaternary Epochs, though Gregory has indeed pointed out that the crest of the Great Dividing Range must have been experiencing a gradual westerly shift and diminution in altitude owing to the headward erosion performed by the easterly flowing rivers. Since this implies a reduction of intake area, he reaches the conclusion that the present absorption from rainfall is probably insufficient to feed the Basin, though such an action might have been adequate in the past.

Australian geologists appear to favour the view that there was a complete withdrawal of the sea from over the limits of the Basin after the deposition of the Desert Sandstone. Because of the widespread development of marine tertiaries in the Murray River, Adelaide and Eucla basins, and from other considerations, there is just a possibility that similar beds extended into the heart of the continent, but were subsequently removed by denudation; in this connection the evidence from Western Australia is very suggestive. Certainly, as stated further back, such a history would help to explain the abnormally high temperature within the Basin.

Modification by warping of the primitive drainage is to some extent evinced by the relationship of the present river systems to the sub-surface contours of the Basin. The ridging up of the floor at the narrowest part of the hollow —between A and B—coincides with the water-parting between the Flinders and the interior drainage, making allowance for some capture effected by the former river.

The deep trough south-west of Longreach is coincident with the courses of the Thomson and the Barcoo rivers, the watershed between these rivers and the Darling system

agreeing in position with the underground ridge between Charleville and Bourke; coincidence in plan is found even in the case of the tributaries between Roma and Warren. Howchin again has pointed out the modifications of the interior drainage brought about in the south-west by the ridging up of the Mount Lofty Ranges and by the trough-faulting in the Spencer's Gulf—Lake Eyre region.

In addition to this gentle warping the much more extensive upheaval just east of the Great Dividing Range came about, whereby the Jurassic beds were brought up some thousands of feet above their level at the centre of the Basin and laid bare along its eastern margin. If Jack's views in regard to the stratigraphical relationships of the Desert Sandstone to the north and to the south of Hughenden are correct, certain portions of the intake beds must have remained sealed beneath an unconformable cover of Upper Cretaceous strata as well of Tertiary basalts until a comparatively late period.

Even without any addition of rain to the outcrops, this tilting would have produced a gravitative movement of the contained or connate water towards the west, and it is suggestive to find that the Cloncurry-Richmond and the Bourke-Charleville "rolls," when extended, strike the backbone of Queensland, where the latter attains its maximum height, and where the Jurassic beds rise to over 2,000 feet above sea-level. It is precisely there, also, that the high potential regions are located, and, when comparisons are made with the Hydraulic Diagram (IV), the surface contours of the Thomson Valley will be seen to conform with the courses of the isopotentials to an unexpected degree.

This suggests that very late earth movements rather than mere rainfall, may have determined the main distribution of potential over the eastern side of the Basin.

X. The Relation between Volcanism and the Artesian Supply.

The suggestion made by Gregory of a probable interconnection between the Artesian water and Tertiary volcanicity is a fruitful one and worthy of elaboration, for it is worth observing that De Launay[1] has shown how in Europe there is an almost absolute restriction of springs with free CO_2 to the regions of Tertiary and recent volcanic activity, *e.g.*, the Auvergne, Bohemia, the Carpathians, Appennines, etc.

It is not surprising, therefore, to find both high potential areas in Queensland still possessing considerably developed though now much dissected cappings of the presumably earlier Tertiary basalts (Diag. III). In the northern area the lavas stretch westwards across the Rolling Downs series for some distance down the Flinders valley, and in the opposite direction cover a wide region about the headwaters of the Burdekin river. They are linked to the southern area by the flows around Clermont and Springsure.[2]

Further to the south-east again basalts crown the Bunya-Toowoomba watershed, and are represented in New South Wales, between Yetman and Warialda, Moree and Narrabri and around Dubbo.

There can be no doubt from the number of outliers scattered around each of these detached centres, that these basalts must have had in Miocene times a very much wider distribution, and it would appear not unreasonable to surmise that they formed a belt—interrupted perhaps only here and there—extending the full length of the present eastern margin of the Basin.

It is significant again that, while they lie upon palæozoic rocks now and then outside the Basin and within it upon

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[1] L. De Launay, Recherche, Captage et Aménagement des Sources Thermes Minerales, Paris, p. 130, 1899.

[2] Jack and Etheridge, Geol. and Palæont. Queensland, pp. 581-6, 1892.

the Cretaceous, they rest for the greater part of their breadth upon a surface cut very obliquely across the outcrop of the Jurassic intake beds. The later Tertiary tilting movement has brought about a gentle inward dip of these strata and their lava covering. Some of the volcanic foci from which these or perhaps the younger basalt flows were erupted, have been observed in the neighbourhood of Hughenden, quite a number in that of Clermont—the former within, the latter just without the Basin—and others towards Herberton; doubtless many more of these centres await discovery.

In addition thereto, and perhaps of greater importance, are the Miocene alkaline (trachytic) lavas and intrusive dykes and plugs (rocks all rich in soda, but poor in lime) that are found along a broad belt stretching with breaks in a curving direction from Casterton in Victoria to Clermont and Rockhampton in Queensland.[1] These were followed by great basalt outpourings, the lavas issuing from cones, and either forming great sheets or having flowed down valleys eroded during mid-tertiary times.

This eruptive phase near the close of the Pliocene was accompanied or immediately followed by great continental uplift with some block-faulting, while on the extreme eastern edge of the continent the forces of compression acted in a westerly direction.

From analogy with other parts of the world, *e.g.*, South Africa, where similar structures occur and similar geological episodes have been experienced, it is to be expected that beneath the uncompressed and only feebly warped Artesian Basin, the older strata will have been injected by igneous matter, possibly on an extensive scale. The existence of tertiary sills, dykes and even batholithic intrusions below this interior region, or at least its eastern part, is a

[1] T. W. E. David, Handbook of Australia, B.A.A.S., ch. vii, 1914.

logical deduction, and is strongly supported by the abnormally high temperature gradients found underfoot. Pittman's testimony regarding the presence of intrusive dolerite in some of the bores in New South Wales is welcome, also his admission that the high temperatures in some of the wells may be due to expiring volcanism.

The Warrumbungle Mountains[1] overlooking the south-eastern corner of the Basin are important in this connection, because the numerous vents and plugs piercing the Jurassic beds indicate the existence below the surface of an extensive laccolitic mass, from which through prolonged differentiation, a suite of alkaline (soda-rich) rocks of great variety, both effusive and hypabyssal, has been derived and erupted. The same again is the case in the marginal range of the Nandewars,[2] where in addition faulting has played a part, while another region of alkaline rocks has Dubbo at its centre.

The effect of heated waters charged with silica and silicates, derived by contact with or directly from the cooling magma, is proved by the diatomite deposits interstratified with the trachytes and tuffs, and by seams of opal, chalcedony and silicified breccias in the Warrumbungles, such silicification having been noticed in the Nandewars also, and in the basalts at Springsure near Clermont.

Again, the Warrumbungles, and to a lesser degree the Nandewars, are well known for their curious permanent springs high up among the mountains, difficult to explain by hydrostatic pressure alone. Jensen,[3] who favours the view that CO_2 set free by rock decomposition may be assisting in bringing the water to the surface, considers that this action is probably inadequate, while Symmonds[4]

[1] H. I. Jensen, Proc. Linn. Soc. N.S.W., xxxii, pp. 557 – 626, 1907.
[2] H. I. Jensen, *ibid.*, xxxii, pp. 842 – 914, 1907.
[3] H. I. Jensen, *ibid.*, xxxii, pp. 579 – 581, 1907.
[4] R. S. Symmonds, *loc. cit.*, pp. 23 – 33; also App. A by H. I. Jensen.

regards the waters as possibly of magmatic origin; their chlorine content is invariably low.

Ever since the pioneer work of Bischoff, geologists have recognised that in the waning stages of volcanicity CO_2, N, and H_2O, are given off at low temperatures, for example in Java, in the mofettes of the Eifel, etc., and it may not unreasonably be surmised, that in Australia these gases were set free, both below ground as well as at the surface, so that a large proportion of the CO_2 required for the carbonation of the artesian waters could have been derived from such volcanic sources.

It is worthy of note that the Coonamble area, adjoining the Warrumbungles, is specially characterised by the presence of free CO_2 in its waters.

That such evolution of CO_2 has not wholly ceased, is indicated by the existence of certain warm springs with free carbon dioxide, outside the eastern limits of the Basin, but still within the region of volcanic activity, *e.g.*, the Einasleigh (180° F.) Oakvale (hot) and Innot Springs (158° – 168° F.) between Georgetown and Herberton in Queensland, rising in a tract of granite, gneiss and metamorphic rocks, and the tepid spring at Rock Flat near Cooma in the extreme south-east of New South Wales, issuing from Devonian strata overlain by basalt. The close association of all four with basalt may be regarded as evidence for the volcanic origin of these thermal springs, and Jack[1] has connected the first and third with the younger phase of volcanicity.

While alkaline carbonates exist in all four waters, they predominate in the second and fourth, the ratio of this salt to the sodic chloride being respectively 1 : 2, 5 : 1, 1 : 2·5 and 8 : 1.

[1] Jack and Etheridge, The Geol. and Palæont., Qld., pp. 586, 626, 1892.

These, the similar water at the Zetz Spa (Ballimore)[1] east of Dubbo, struck at 550 feet in a bore in Permo-Carboniferous beds, and highly charged with CO_2, and the highly alkaline water in the Maria Creek bore on the Central Railway in Queensland in the same system, prove that waters of the Great Basin type can be found in rocks both sedimentary and plutonic older than the Jurassic, while the position of the cold Helidon Spa with its preponderance of sodic carbonate is also significant. From this and from the collateral evidence presented earlier, it seems highly likely that waters carrying carbon dioxide have been and probably are still being fed up into the water-bearing beds through fissures in the basement rocks.

Of direct evidence within the basin very little could be expected under the circumstances, but there are three items worth citing in support:—(1) the abnormally hot waters struck on the Northern Railway at Strathfield (130° F. at 841 feet),[2] and at Nonda Downs or Clutha Resumption (180° F. at 1,340 feet—if this be correctly printed); (2) the observation that flakes of granite are being brought up by one of the warm mud springs at Mount Browne[3] on the lower Flinders river, presumably from the granite basement known to lie at a shallow depth hereabouts (see earlier); (3) the Oxton Downs bore on the Northern Railway, where the water was tapped in a crack in the granite, the significance of which was pointed out by Gregory.

The evidence quoted by Pittman[4] shows that, after boring slowly for some weeks in hard granite, the tools dropped suddenly six or eight feet, and that the boring then followed this crack down until the rock became hard again; flakes

[1] E. F. Pittman, The Mineral Resources of N.S. Wales, p. 449, 1901.

[2] T. W. E. David, Journ. Roy. Soc. N.S.W., Vol. xxvii, p, 423, 1893.

[3] T. W. E. David, *ibid.*, Vol. xxv, p. 294, 1891.

[4] E. F. Pittman, Problems of the Artes. Water Supply Austr., Geol. Surv. N S.W., p. 20, 1908,

of granite were brought up by the bailer. Flowing water was obtained near the bottom of this deep crack, but the supply was much smaller than in the surrounding bores, but with a greater static head.

There was no evidence to show that sandstone filled the crack, and therefore, despite Pittman's attempt at explanation on these lines, Gregory's view seems far more reasonable. Unless such fissures be highly numerous, the probability of one being struck in the course of random boring would be excessively low.

The Urisino "tidal well" in New South Wales instanced by Gregory in support of his views, is hardly a suitable subject in this respect, on account of the obscurity of the phenomenon; the investigation of the behaviour of certain "oscillating" bores near Cradock[1] in the Cape Province, has shown some of the difficulties inherent in elucidating the causes of such movements of water-level.

Taking into consideration the irregularities of temperature, pressure and salinity, as pointed out under those separate heads, each of which is admittedly small but collectively of appreciable weight, the composition of the waters and their associated gases, the contentions stated above appear to be justified, and agree with David's[2] dictum that springs connected with faults obviously supply part of the artesian water. At the same time waters of a similar type, either plutonic or resurgent, could have entered the broad outcrop of the Jurassic beds beneath the covering of basalts and thus assisted in the charging of the reservoir.

XI. The Closing History of the Basin.

Elaborating this conception, the additions both along the eastern outcrop and from below are suggested as having

[1] A. Young, Trans. Roy. Soc. S. Africa, Vol. III, p. 61, 1913.

[2] T. W. E. David, Handbook for Australia, B.A.A.S., p. 280, 1914.

gradually displaced the residual waters, that had been throughout Cretaceous and early Tertiary times either stagnant or imperceptibly circulating through the sandstones, this action being hastened by the westerly tilt that in late Pliocene or Early Pleistocene times produced a movement of the water-body in that direction. At the same time, as erosion laid bare the intake beds by stripping off the cover of basalt and Desert Sandstone, a progressively greater area would become exposed and available therefore for the absorption of the rainfall, and it might be remarked that in a rough manner the marginal waters are fresher opposite those sections of the intake, off which the volcanic rocks have been denuded.

It was moreover just then that glacial conditions set in over Australia, whereby heavier precipitation was brought about upon the Main Eastern Divide and the intake area more fully supplied.

The static pressures induced over the centre and further side of the Basin became excessive, and, taking advantage of the contact of the Mesozoic strata with the older rocks, and of the marginal coarseness of the Cretaceous beds along both the main boundary of the Basin and the borders of any inliers, the water burst up to the surface over more than half of the periphery, and a steady flow was established with concomitant westerly fall of the potential surface.

The process of elimination of the saline "residual water" would be effected by these, the Mound Springs, while in their turn the magmatic waters would be in process of replacement at the intake by rainfall; when the Salinity Diagram is compared with that showing the Isopotentials (and therefore the direction of flow), the general correctness of this reasoning is strikingly confirmed.

The fresh meteoric additions make their appearance due north of Richmond, between Barcaldine and Charleville,

and about Coonamble; the semi-saline magmatic waters occupy the centre of the Basin, while the highly saline residual types appear on the Gulf of Carpentaria, and along the south-south-western margin between Bourke and Charlotte Waters. In the last-named region, analyses of the waters both of the mound springs and of the marginal bores exhibit high salinities—from 150 to 400 grains of salts per gallon (I, App. Z; II, App. E). That the overlying Cretaceous marine beds are not contributing salt to the waters of the springs in any marked degree in their passage to the surface, is proved by the fact that, when bores are put down in their vicinity (*e.g.*, Coward, Warrangarrana, and Hergott), the analyses agree closely, or the bore-water has a somewhat higher salinity.

The type of water in this quarter, instead of having a high "primary alkalinity" is now characterised by both high "primary salinity" and moderate "secondary salinity," and in accordance with this new system of classification,[1] can be interpreted only as a trapped marine (connate) water but slightly altered; that of the Oodnadatta bore is a good example.

As already stated, of the dissolved solids, sodic chloride exceeds sodic carbonate, while there is often a high proportion of sodic sulphate and some magnesium salts as well. In the deeper bores to the north-east, the waters are nearly normal, as are also those from the mound springs between Boulia and Cloncurry. Upon the hypothesis suggested the high salinity of the water at Normanton can readily be explained.

It is most improbable that the leaching action of the replacing waters could have been completely effective; thin water horizons with weak circulation would naturally have

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[1] C. Palmer, U. S. Geol. Surv., Bull. 479, 1911, and G. S. Rogers, Economic Geology, Vol. XII, p. 78, 1917.

been diluted the least, and it is suggested therefore, that some of the supplies struck above the main flow, represent wholly or in part, "residual waters" enclosed in the strata at the time of their deposition or introduced at an early stage of the Tertiary.

According to the rate of flow calculated, assuming the *same* fall of the hydraulic surface as at present, water would take about 20,000 years to cross the widest part of the Basin, and knowing the great affinities that fine sediments and clays have for soluble salts, it is only to be expected that the beds would require the passing of much water to accomplish the forward transference of saline matter, so that the time involved for this action may therefore have been very considerable.

While the total yield of the Mound Springs cannot be estimated, even roughly, all observers are agreed that their output, judging from their numbers, must be enormous—take the case alone of the Boiling Springs near Coward Springs in South Australia, estimated at a million gallons per day—while there are many small springs on the eastern side of the Basin as well (I, pp. 50-1).

Their action as safety-valves implies that they were able to discharge water sufficiently rapidly to prevent the excessive rise of the hydraulic surface in that quarter. It is reasonable to conclude therefore, that this volume might have been approximately equal to the quantity absorbed by the intake and transmitted westwards, due allowance being made for the amount lost by leakage below the Gulf of Carpentaria, and perhaps some to the south and southwest also.

On the other hand the observation of extinct mound springs, such as on the western plains of New South Wales by Pittman, in South Australia at Dalhousie Head by H. Y. L. Brown, and near Langlo Downs (S.W. of Tambo) by

G. N. Griffiths—at the first-named in great numbers—must be correlated with a reduction of potential in the south-west. This could have been due either to too great a leakage, or perhaps to a diminution of effective area brought about by the headward erosion and to the lowering of the water-shed, as discussed earlier, or probably with much greater likelihood to the lesser rainfall following upon the period of Pleistocene glaciation, or all these causes may have acted in combination.

If this be correct, then the conclusion seems inevitable that *the Basin has passed maturity and is now in decline.*

Some support is also afforded by the observation that the Einasleigh Hot Springs near Chillagoe appear to be drying up, as many of the basins are empty and much of the calcareous sinter is crumbling away.

In view of the great drain being made by the existing bores, estimated at between 600 and 700 million gallons per day, it remains to be seen whether there will come about a corresponding reduction in the output of the mound springs; that some of them have already been affected is indeed indicated by the reported diminution in flow of those at Saxby Downs in Queensland (II, § 2801).

When to this is added the disquieting fact that the yield of the bores, is as a whole, falling off at the rate of perhaps as much as 6 or 7% annually, the fear arises lest the reduction in flow be due not merely to the temporary readjustment towards equilibrium, but to an actual overdraft upon the existing resources of the Basin. One can hardly accept Jack's opinion that in view of the vast submarine leakage, the withdrawal by bores is infinitesimal in comparison, with the inference that no control or restriction would be necessary.

There is great need therefore, until such time as sufficient evidence be forthcoming to decide this question, to legislate

in the direction of curtailing boring operations, of controlling and restricting the outflow of those in existence, and of preventing the underground leakage by means of watertight contacts between the casing and the sealing beds. In fact Artesian water ought to be recognised as an asset vested in the State, and to be conserved and used in the most judicious manner. It may even become necessary for the State to carry through a scheme of nationalisation of all the bores in the Great Basin, and to institute a system whereby the amount permitted to flow from each borehead would have to be determined by a Board with State control.

XII. Conclusion.

Any working hypothesis must take into account the previous history of the Basin, its development, and the processes by which the reservoir became charged; in this the generally accepted Meteoric Hypothesis fails entirely.

The conclusions arrived at by the Author agree with those of Gregory, in so far that the waters are regarded as composite in character, and originating from three distinct sources:—(1) residual (mesozoic), (2) plutonic, and (3) rainfall of an earlier epoch (tertiary).

Of these, the bulk of the residual water is considered as having to a great extent been replaced subsequently by alkaline waters, fed in at the sub-basaltic outcrops as well as from below, being evolved by, or derived from, the hypabyssal and plutonic masses, from which the younger Tertiary basalts, alkali-trachytes, etc., were derived. Aided by an escape on the west, they permeated the Jurassic beds, and the reservoir became charged with waters of fairly uniform composition, in which carbonate of sodium predominated over chloride. On the east, the stripping off of the basalt, etc., from the intake beds, accompanied by the pluvial conditions in the Early Pleistocene, led to the

accession of surface water, which is not only in its turn displacing the earlier accumulation, but also carrying salts in and downwards from the actual outcrop. Whether this stage is marked by the eastern edge of the belt of moderately high salinity running from Winton to Charleville is problematical, but to the east of Roma, little water seems to be passing westwards into the reservoir, and probably for this reason the beds have remained saline there.

In opposition to Gregory, however, the meteoric supply is believed to be the predominant one, and the contribution from plutonic sources subordinate in amount *at the present day*, yet of the water actually stored, and now available, quite a large, possibly the greater, proportion may have been derived from other than meteoric sources, as suggested.

In concluding, a few words might be said in reference to some of the problems of the Basin that await investigation.

One of the most important of these is the delimitation of the Cretaceous and the Jurassic beneath the surface, and the probable existence and distribution of Lower Cretaceous Artesian horizons. A second is the nature of the Artesian series on the eastern and south-eastern margin, and their stratigraphical relationship to the Triassic and Permo-carboniferous strata there. A third is the investigation of the Tertiary igneous lavas, intrusions and volcanic centres, both with special reference to their behaviour towards the Jurassics, and regarded as a source of deep-seated waters and of carbon dioxide gas. The geological survey of the two high potential areas ought to furnish valuable data on a number of points.

On the physical side numerous lines of inquiry suggest themselves, such as the downward rate of temperature increment, both of the strata and the waters they yield, the variations just above or within the main flow, the

general distribution of temperature increment and variation of such in shallow parts, the presence of abnormally hot or cold waters and other thermal anomalies both in bores and in springs.

Information should be collected upon the existence and limits of "inlying" high potential areas, of variations of pressure with depth and with time, of the pressures in the several water-horizons; of variations in flow, the relation of the latter to porosity and the absolute values of the "transmission constants," the interference of bores and the causes bringing about loss of head. Much work could be done in measuring the relative volumes of gases evolved, in determining their effect on the flow, their relative proportion in east and west, etc.

Chemical investigation should be concentrated upon the salinity and origin of the waters, more especially of the marginal types and intake waters, upon variation of composition with depth, upon the nature and origin of the gases with special reference to the rarer elements, and upon the study of the mound and other thermal and cold springs.

From the engineering aspect much more of a similar nature might be said.

Summing up, it may be stated without fear of contradiction, that probably no other geological problem is so many-sided as that of the Great Australian Artesian Basin, bristling as it does with puzzles of all kinds, both from theoretical and practical points of view.

It is to be hoped therefore, that the Commonwealth Government may realise the extremely important but complex nature of the problem, and sanction some comprehensive scheme for its thorough study from every aspect.

The discussion given above is merely an outline, and, though the arguments are weak at times and the evidence

in support thereof slender, it is hoped that the suggestions made may pave the way to a fuller search for the data requisite for the solution of the many difficulties that confront the inquirer.

Table A1.—*Discharges induced in a bore by small amounts of rising Gas.*

Based on the formula $v = \sqrt{\left(\dfrac{a \times 34 \times 2 \cdot 3 \log \dfrac{h + 34}{34}}{1 + \dfrac{4fh}{d}}\right)}$ in feet per second.

Percentage of gas a evolved at surface at atmospheric pressure.	Cubic feet of gas evolved per day.	Velocity of water in feet per second	Discharge of water in gallons per day.	Depth of bore-hole of diameter six inches.
0·25	33·5	0·79	83,720	500 feet
0·50	90·7	1·17	113,400	
1·00	268	1·58	167,440	
2·00	726	2·34	226,800	
0·25	26·5	0·63	66,415	1,000 feet
0·50	75	0·89	93,935	
1·00	212	1·26	132,830	
2·00	600	1·78	187,870	
1·00	166	0·98	103,690	2,000 feet
1·00	143	0·85	89,520	3,000 feet
1·00	127	0·75	79,420	4,000 feet

Table A 2.—*Volumes of Gas required to produce large flows of Water in a six inch bore, 2,000 feet deep; $f = 0 \cdot 00575$.*

Discharge of water induced, in gallons per day.	Ratio of *proportion of gas to water* at atmospheric pressure.	Equivalent head induced in pounds per square inch.	Volume of gas set free at the surface in cubic feet per day.
125,000	0·015	0·4	290
250,000	0·058	3·5	2,320
500,000	0·234	14·1	18,600
750,000	0·535	32·2	64,200
1,000,000	0·961	57·8	153,900
1,250,000	1·54	93	309,400
1,500,000	2·32	140	558,000

(The higher figures are uncertain.)

Table B.—*Frictional losses in borehole casing with varying discharge.*

Based on formula:—Loss of head $= \dfrac{4\,f\,v^2}{2\,gd}$

v = velocity of flow in feet per second; d = diameter of casing in feet; g = gravitation constant; — = depth of bore in feet; and $f = 0{\cdot}00575$.

Frictional losses in pounds per square inch.

Discharge of water in gallons per day.	FIVE-INCH CASING.			SIX-INCH CASING.			
	Depths in Feet.			Depths in Feet.			
	1,000	2,000	3,000	1,000	2,000	3,000	4,000
50,000	0·2	0·4	0·7	0·1	0·2	0·2	0·3
100,000	0·7	1·4	2·8	0·3	0·6	0·9	1·2
150,000	1·5	3·1	6·2	0·6	1·3	1·9	2·5
200,000	2·8	5·6	11·1	1·1	2·2	3·1	4·4
300,000	6·2	12·5	25·0	2·5	5·0	7·5	10·0
400,000	11·0	22·1	44·2	4·4	8·8	13·3	17·8
500,000	17·1	34·2	68·3	6·9	13·9	21·0	27·8
600,000	25·0	50·0	100·0	10·0	20·0	30·0	40·0
700,000	34·0	68·0	136·0	13·6	27·2	40·9	54·0
800,000				17·8	35·5	53·2	71·0
900,000				22·5	45·1	67·7	90·2
1,000,000				27·8	55·6	83·5	111·3
1,100,000				33·5	67·0	100·5	134·0
1,200,000				40·0	80·0	120·0	160·0

For temperatures of discharge in the neighbourhood of 100° F. and 150° F. multiply these results by 0·9 and 0·8 respectively.

THE SYDNEY WATER SUPPLY.

By T. W. Keele, M. Inst. C.E.

[*Read before the Royal Society of N.S. Wa es, July 4, 1917*.]

At the present time, when the Cataract and Prospect Reservoirs are practically full to overflowing, the Cordeaux Dam also having been commenced, which, on its completion in about four years' time, will make a further large addition to the storage, and with the prospect of a succession of favourable seasons, after so long a period of decline in the rainfall as we have experienced, it may be considered inopportune to draw your attention to the subject of the water supply of Sydney.

I think, however, I shall be able to advance some very good reasons why this question should not be left in abeyance, and I hope you will be interested in a proposal I will presently submit for your consideration, which, if adopted, will effect a very considerable alteration in the system, and will result in greater economy and efficiency, and, above all, security of the supply.

In an investigation of this nature it is necessary, in the first instance, to inquire into the rate of increase of the population to be served with water in order to arrive at a reliable estimate of future requirements. It is always difficult to determine with accuracy the number of persons to be served with water, for the reason that the tables supplied by the Government Statistician refer to the population within municipal boundaries, whereas the system supplying Sydney serves a very wide area entirely outside the boundaries of the metropolis, in addition to those within the city and suburbs. To arrive, therefore, at an

approximation of the number of consumers, the Water Board follows the usual practice of such authorities by ascertaining accurately the number of houses connected with the water service, and allowing five persons to each house.

The statement in Appendix shows the annual rate of increase of the population arrived at in this way. It will be seen that from 1888 to 1908 the increase was fairly uniform at the rate of about $2\frac{3}{4}$ per cent. per annum. From this on to 1916, the curve shows a very remarkable rise as follows:—1908-9, 3.514 per cent.; 1909-10, 4.16 per cent.; 1910-11, 4.073 per cent.; 1911-12, 5.026 per cent.; 1912-13, 6.138 per cent.; 1913-14, 7.022 per cent.; 1914-15, 5.807 per cent.; and 1915-16, 4.46 per cent.

It will be seen that up to the commencement of the war the increase was very rapid, and it would be exceedingly difficult to forecast the rate under such circumstances. The decline for the two following years up to June of this year has, no doubt, been largely owing to the decline in building operations, owing to the war, and the large number of men who have gone to the front, and this may be expected to continue for some years. In view of the fact that all forecasts of the future increase of population to be served with water have been under-estimated, and, seeing that the population of New York increased at about 4 per cent. per annum from the time it numbered 1,000,000 to 2,750,000, I think it would be safe and reasonable to assume that we shall experience a similar rate of increase over a like period.

The water for the supply of Sydney, as you know, is derived from a catchment area of 350 square miles, in which the Nepean River takes its rise. It is of exceptional quality, and requires no filtering. Probably no other city in the world can boast of greater purity of its water.

It is conducted to Prospect Reservoir—40 miles—through a conduit, 33 miles of which are in open canal; from Prospect to pipehead by a further length of five miles of open canal; thence to Potts Hill, 5 miles, the water is taken through two 6-feet diameter wrought iron pipes laid upon the surface of the ground. From Potts Hill the water is taken underground in pipes, and passes into circulation throughout the city.

Owing to its physical conditions, the main portion of the supply, namely, 62 per cent., has to be lifted to the higher zones by pumping, the principal pumping stations being at Crown-street on the south side, and Ryde on the north side of the Harbour.

The percentage of water pumped has been gradually increasing, until 1914-15, when it reached 68 per cent. The drop to 62 per cent. last year was probably to a great extent caused by the prohibition of the sprinklers, owing to the rapid diminution of the storage in the reservoir, caused by the protracted drought. On reference to Mr. Clarke's report (18th May, 1877) on the Sydney Water Supply, it will be seen that it was not then anticipated that so large a percentage of pumping as has occurred would be required; but it is a remarkable fact that, whenever facilities for obtaining water on the higher levels have been given, extensive settlement has followed—the public evidently preferring the higher zones for residential purposes; and when it is reflected that as more and more of the foreshore of the harbour is being resumed for commercial purposes, the people will naturally be compelled to resort to the higher levels. Seeing that the gravitation limit is 141 feet on the south side, and only 97 feet on the north side, and that very tall buildings in the city area above that limit are increasing rapidly, I think it is reasonable to anticipate that for years to come the per-

centage will not be reduced below the level it has already reached.

Having briefly sketched the manner in which the water is brought into the city and distributed, the important question of security may be referred to. Are the citizens satisfied that their water supply is as secure as it should be, and that when turning on their taps they may reasonably expect to draw from them all the water they require? Apart from the sufficiency of the storage, which I shall presently refer to, there has been recently developed a new and startling danger, namely, the deliberate interference with the supply to the higher zones by industrial strikes, which have for their object either the partial suspension of the supply of coal by the "slowing down" process, or its total stoppage when the strike has lasted sufficiently long to exhaust the immense reserves of coal which must be maintained to meet such emergencies. The recent great industrial strike has surely brought forcibly before the citizens of Sydney the very precarious position in which they can be placed by a stoppage of the coal supply. The various public utilities were all, more or less, affected, but when we consider that we were actually within measurable distance of an interference with the pumping of water to the higher levels, and that a continuance of the strike would have resulted in the pumping engines ceasing work, the seriousness of the situation is at once brought forcibly before us. We might possibly manage for a little while without gas, or electric light, but we cannot exist without water for domestic purposes and the flushing of sewers. The complete stoppage of water for even a day or two would indeed be a calamity, but it is not too much to say that a further continuance would mean an exodus from the city before the expiration of a week.

Following quickly upon this coal strike the citizens were afforded another demonstration by a band of lawless men

that no building or public work of any description above ground is immune from their attack. I have endeavoured to show what would be our predicament through the holding up of the coal, so far as the water supply to the higher zone is concerned, but it is only those who are fully aware of the manner in which the water is brought into the city, who can realise how precarious is our dependence on the daily supply of the precious fluid. It is sufficient here to say that no city of the importance of Sydney, with close upon one million inhabitants, should be satisfied with only one conduit, and that one wholly above ground for about half its length, and therefore subject to interference in a manner which it is obviously undesirable here to enlarge upon.

The reasons above stated are quite sufficient in themselves to cause anyone interested in the water supply to ponder over means for its better security and improvement. That such is very necessary has also been recently demonstrated by the state of the reservoirs at the termination of the drought in September last year, when we were so near to a water famine, there being less than 200 days' supply on a very much reduced consumption, when the situation was relieved by bountiful rains at a season of the year when they were not usually expected.

It is nearly seven years ago, namely, in August, 1910, that the Public Works Committee inquired into a proposal for the amplification and improvement of the City Water Supply. The reference included works for improving the distribution of the water only, but although the question of increasing the storage did not form part of the reference, the chairman very early in the inquiry recognised its importance, and the matter was fully investigated, important evidence on the subject being given by the officials of the Water Board, and also by the late Mr. Wade and

myself, and the Committee were much impressed with the necessity of increased storage, and drew special attention to the matter in their report.

No action appears to have been taken, so far as the construction of any works is concerned, from that time—seven years ago nearly—until the decision in September last to commence the building of the dam on the Cordeaux River.

It is estimated that it will take four years to complete this work, during which, if we have favourable seasons, no inconvenience may be felt; but, on the other hand, if they should be unfavourable, and droughty conditions prevail, it is quite possible for the situation to be actually worse than in last September.

With a population of 917,990, increasing at the rate of 4 per cent. per annum, the reduction in the reserve storage, after allowing for the daily consumption and loss by evaporation, etc., would amount to eighty-four (84) days' supply in four years, assuming that the reservoirs remained full all the time; but if the weather conditions were similar to the four years preceding September last, then it is evident that the reserve storage in 1920 would be very much less than it was in 1916, unless some water was conserved by the new dam during construction. Our experience, however, while building the Cataract Dam, showed that too much dependence must not be placed upon this.

Sufficient has been said in this matter to show that, in a climate like ours, and especially where the supply is derived from storage reservoirs, it is absolutely necessary that such provision should be of the most ample character. Leaks have occasionally occurred in the best constructed works, necessitating the emptying of the reservoir to effect repairs. We have had our own experience with

Prospect Reservoir, which it is unnecessary to dilate upon, beyond stating that, as a consequence, no reliance can be placed on what previously was regarded as a reserve storage in that reservoir, namely, the 5,000 million gallons below the gravitation limit.

In my opinion, we should in future make every endeavour to work up and permanently maintain (if I may be permitted to so express myself) a reserve storage of not less than 600 days, equalling 1.64 years. Indeed, it would be wiser to make it considerably more than this. That it can be done without making any appreciable strain upon the ratepayers will be shown presently.

In 1921, assuming that the Cordeaux is then completed, the population at 4 per cent. increase will have reached 1,112,000 people, consuming, say, 52 gallons daily per head, the daily consumption will amount to 57,821,000, and, assuming losses from evaporation, etc., to amount to 15 million gallons daily from the three reservoirs, the total daily loss will amount to 72,821,000, which would result in a reserve storage capacity of 587 days, or 1.61 years, which it will be observed is less than the reserve I have suggested. Assuming that it will take four years to provide further storage elsewhere, by 1924 the consumption and evaporation will have amounted to 87,546,000, and the reserve storage under the most favourable conditions will have decreased to 488 days' supply, equalling 1.33 years, or actually less than the reserve storage at the present time (in May, 1917), when we are just starting to build the Cordeaux Dam.

In 1925 the new storage reservoirs should be ready to take up the duty. I have not yet mentioned where they should be located, but presumably the Avon would be one. It would have a catchment area of 63 square miles, or 13

square miles greater than that on the Cordeaux. It would not, however, be wise, without further information as to its capacity for storage, to assume a greater storage than the Cordeaux, namely, 15,859 million gallons. This, however, would be 9,500 million gallons less than the reserve storage I have already advocated, namely, 600 days' supply, and I would here strongly advise that it should come from the Woronora and O'Hare's Creek Reservoirs, the sites for which have already been surveyed, and their capacity ascertained to be 7,565 millions on the Woronora and 2,000 millions on the O'Hare's Creek. A tunnel ten miles in length would be necessary to convey the combined waters to the existing canal at the Sugar Loaf. By the construction of the tunnel, the drainage from 85 square miles of country, the discharge from which equals 23,899 million gallons in a year of mean rainfall, would be added to the present catchment area of 350 square miles, making a total of 435 square miles. If these works were commenced next year they would, together with the Avon Dam (to be commenced in 1921), be completed in 1924 and ready to commence duty in 1925, when the population would have increased to 1,300,823 consuming 60 gallons per head per day. The daily consumption would amount to 78,049,380 gallons, and, allowing for evaporation and other losses from the six reservoirs, the total loss would amount to 108,049 millions daily. The reserve storage would, therefore, amount to 623 days' supply, or 1.7 years.

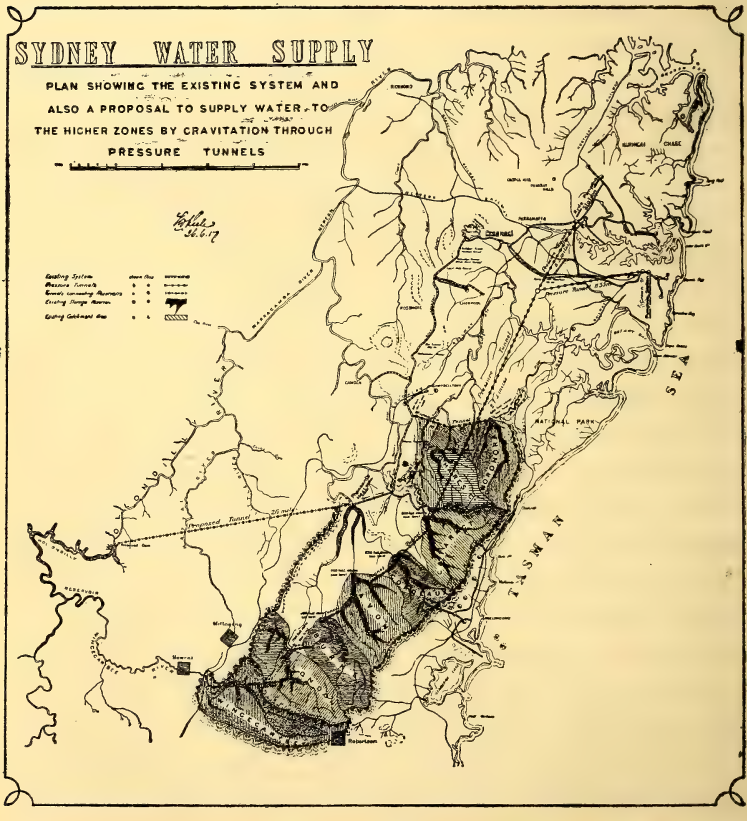
I will not weary you by taking you step by step along the course necessary to determine the storage capacity that will become necessary from year to year as the increase of population makes its demand for water. We cannot afford to live from hand to mouth any longer.

Enough has been said to impress upon you the absolute necessity of forecasting our future requirements and mak-

ing provision to meet them. It is necessary, however, to say that the storage I have mentioned by no means exhausts the capabilities of the catchment area. There are three more, namely, the Burke, the London and the Chain-of-Ponds reservoirs, which should be capable of impounding about 29,000 million of gallons, and, in addition to those, there are two others of 20,000 million gallons situated in the cap of the range at an elevation of over 2,000 feet on the Wingecarribee River, which takes its rise near the village of Robertson and drains into the Wollondilly River. There is an area of 55 square miles, which can be made available by intercepting the water by a dam at a point above the junction of Wingecarribee Creek with the river, and conveying it by a tunnel seven miles long into Doudles Folly Creek, which drains into the London River within the present catchment area. A second dam on the Wingecarribee area could be constructed on the site suggested by Mr. Gipps when giving evidence before the Royal Commission in 1902. The objection then taken to Mr. Gipps' proposal was that the water might be contaminated by the drainage from the village of Robertson, but it will be seen from the map that there should be no difficulty in diverting this drainage and conveying it outside the catchment area, and provision in my estimate of cost has been made for the resumption of any other holdings that may be considered objectionable. The drainage from the town of Mittagong does not come within this catchment area at all.

An inspection of the table "A" on page 219 will show that the storage capacity of the reservoirs I have referred to, including Prospect Reservoir, amounts to 116,337,369,000 gallons, while the discharge resulting from the mean annual rainfall over the respective areas from which they derive their supply amounts to 140,684 million gallons. If these reservoirs, therefore, are all completed in 1937, the posi-

tion would be then:—Population 2,082,661, increasing at 4 per cent., consuming, say, 63 gallons per head per day. The total daily consumption would be 131,207,643, and, with evaporation and other losses, amounting to, say, 52,000,000 gallons per day, the total daily loss from the reservoirs would be 183,207,643 gallons. The reservoirs, if full at that time, would therefore be capable of affording a reserve storage of about 600 days, or 1.64 years.



It will thus be seen that, in order to maintain this reserve, it will have become necessary to obtain a further supply capable of meeting the requirements after the year 1937.

STATEMENT "A."

	Storage capacity of reservoirs in millions of gallons.	Catchment areas in square miles.	Average annual rainfall over catchment areas in inchss	Percentage of rainfall discharged	Discharge from catchment areas resulting from average annual rainfall in millions of gallons.
Wingecarribee No. 1......	10,000	55	50	44	17,545
Wingecarribee No. 2......	10,000				
Chain-of-Ponds	7,000	14·5	36	44	3,330
London	10,000	38	48·5	44	11,758
Burke	12,000	36	48·5	44	11,139
Avon	15,000	63	50·49	44	20,294
Cordeaux	15,859	35	50·49	44	11,275
Cataract	21,411	50	50	44	15.950
Woronora	7,565	29	50	44	9.251
O'Hare's Creek	2,000	28	44	44	7,860
Prospect	5,502				
Totals........	116,337	348·5	48·75	44	108,402
Area of the lower Cordeaux Avon, and Nepean Rivers, draining into Nepean Tunnel at the Pheasant's Nest, and thence by the canal to Prospect Reservoir ..	...	111	36	44	25,494
Area draining into the Woronora Tunnel and thence via the canal to Prospect Reservoir	...	28	38	44	6,788
Totals...	116,337	487·5	45·23	44	140,684

The above estimate of discharge from average rainfall is a conservative one, and is probably greater than the amount stated. Prospect Reservoir would probably be maintained by the drainage from the Woronora Catchment Area alone. It will be seen, however, that any deficiency would be made up from the drainage from the area of the lower portion of the existing Catchment Area, namely, 111 square miles. There would be, therefore, an amount equalling 20,000 million gallons annually going to waste, which might be conserved by impounding it in a reservoir which could be formed by a dam at the junction of the Cordeaux and Nepean Rivers.

The only other sources capable of affording so large an additional supply as 80 million gallons daily within ten years are the Wollondilly and the Cox Rivers, either singly or combined, as they would be in the Warragamba. As

the site for this dam is situated at too low a level (namely, only 50 feet above high water at Sydney) to be connected with the existing system, and would therefore require a separate conduit into the city, and as a dam at a higher elevation on the Wollondilly can be connected with the existing system, and as I shall presently show that the cost of the water to the consumer would be less from there than from the Warragamba, I would therefore recommend the Wollondilly proposal. Briefly, it will consist in the construction of a dam capable of impounding 63,500 million gallons of available water at an elevation sufficient to admit of its filtration and subsequent conveyance through a tunnel 26 miles in length, discharging into the Nepean River just above the intake of the Nepean Tunnel at the Pheasants' Nest. I am not in a position to say definitely where the dam should be located, but I think the position shown for it on the map will probably not be far out. The work would have to be commenced about the year 1930 in order to be in readiness to take up the duty of supplying the additional water required in 1937. It is interesting to note that by 1946-7 the daily consumption will probably reach such high figures as 211 million gallons, 80 million of which will come from the Wollondilly, and, as the limit of reserve storage to supply that quantity, after providing for evaporation and other losses for 600 days, would then be reached, another reservoir higher up the stream would have to be ready to take up the duty of further supply.

Having forecasted the probable increase of population to be served with water during the next thirty years, and the arrangements with regard to storage which will have to be made for an effective supply to be maintained, I will now submit for your consideration a scheme that has occurred to me, which, if adopted, will bring the whole

of the storage reservoirs on the Catchment Area under complete control to the extent of making the maximum use of the rainfall upon the area, and enabling the reservoirs to maintain not only a constant supply via the present low level gravitation system of open canal to Prospect Reservoir, but also a constant supply of water at high pressure sufficient to meet all demands of the consumers located in the higher zones of the city and suburbs, on both sides of the Harbour, for the next thirty years, thus dispensing altogether with pumping from the time the works may be completed, thereby placing the city in an entirely secure position with regard to its water supply, inasmuch as it would be safe from any interference of any kind whatsoever, and also entirely independent of coal strikes.

The idea of bringing in the water under pressure through pipes is, of course, not a novel one, and no doubt it has occurred to everyone who has ever given a thought to the improvement of the water supply.

The fact that the water is now impounded in the Cataract Reservoir at an elevation which would command all the heights ever likely to be occupied in the vicinity of Sydney has long been recognised, but, on reflection, it has generally been considered that the limited quantity of water from so small a catchment as 50 square miles, does not warrant the expense.

After studying the topography of the present Catchment Area on the Upper Nepean River from a recognizance survey made by Mr. Surveyor Lee in 1902, with the aid of an Aneroid barometer, which enabled him to give spot levels along the various streams, I noticed that the levels of the several sites for future dams in the Cordeaux, Avon, Burke, London and Chain-of-Ponds were such as to indicate that if they were all connected by tunnelling they could be all drained one into the other from the highest at

Chain-of-Ponds, where the bed level is 1,710 feet, down to the lowest at the Cataract at bed level 800 feet, and, as I have already stated that the Wingecarribee area of 55 square miles can be conveyed by a tunnel into the London Reservoir Area, it was evident that the solution of the problem of sufficiency of water at an elevation to warrant the expense of conducting it to the city at high pressure had been reached.

On looking into the question of the conveyance of the water by pipes to the city, I found that, apart from the fact that the metal at the present time is absolutely unobtainable and not likely to be available for probably some years, the cost even at the pre-war prices was almost prohibitive; moreover, there is the difficulty in crossing the Harbour to be overcome. The pipes also as far as Bankstown, 27.3 miles from the Cataract, would have to be laid above the surface of the ground for purposes of inspection and maintenance.

In earlier times this would not have been objected to, but there can be no security in the present day for works of this description, for reasons already referred to. It then occurred to me that if the water be taken through a specially lined tunnel, located in sound rock at a sufficient depth to withstand the pressure due to the head of water in the reservoir, the difficulty might be overcome, and after making out an estimate of the cost I felt sure that the scheme was feasible, and have since beeen confirmed in that opinion since reading Mr. Charles Prelini's paper on the New York Water Supply, volume XCVII, Engineering, 13th March, 1914, to which my attention was directed by my friend Mr. H. G. McKinney, in which the method adopted for conveying the water across valleys, and, in two places in particular, across the River Hudson and the East River, were fully described, and is exactly similar to my proposal.

The difficulty they had to contend with was that, owing to the faulty nature of the rock when crossing the Hudson River, they had to go down 1000 feet below the water level; elsewhere, it was found that sufficiently sound rock was obtainable at not less than 150 feet below the surface of the rock. Their "pressure tunnels" were lined with 4-2-1 concrete, of varying thickness, according to the hydrostatic pressure, up to 17 inches thick below the Hudson River, the tunnels being 14½ feet in internal diameter, to carry five hundred million gallons per day.

I feel sure that in our Hawkesbury sandstone rock it will be possible at a reasonable depth to take the water safely through a tunnel similarly lined, and, in my estimate, have made provision, when passing under George's River, and also across the Harbour to Ryde, to locate the tunnel at not less than 500 feet below high water level with 17 inches thickness of concrete lining.

My scheme provides for a tunnel from the Cataract Reservoir direct to Bankstown, 27.3 miles in length. There it would be bifurcated, one branch going direct to Crown Street Pumping Station, 11.55 miles long, and the other direct to Ryde, 8.3 miles in length. The main tunnel would be capable of delivering 150 million gallons per day to Bankstown, and the branch tunnels would each carry 75 million gallons per day. At the termination of each branch tunnel, the water would be taken up a shaft specially designed at the top to admit of connections being made with the rising mains. The pumping engines could then stop work, and the water would be delivered under the pressure due to the head at the Cataract Reservoir, which would be sufficient to supply the maximum quantity, if required, to Wahroonga, on the north side, or to Waverley, on the south side.

As the time for completing the tunnels depends principally on the number of faces at which the men can work, I have made provision in the estimate for 39 shafts along the main tunnel line, the average distance apart would be 3696 feet and the average depth 300 feet.

In the branch tunnel to Crown Street, I have allowed for 32 shafts at varying distances apart from 1452 feet in the thickly populated portions of the line to 3388 feet where the settlement is not so dense. Along the tunnel to Ryde the greatest distance between shafts would probably be about 7392 feet where crossing the Harbour, which would leave 31,680 feet on the south side, and 4752 feet on the north side, and the shafts would be spaced at distances apart of 3168 feet and 2376 feet, respectively.

The total length of the six tunnels connecting the several reservoirs from Wingecarribee to the Cataract Reservoir, would amount to 20½ miles. Provision has been made for their being lined with concrete throughout, and for their capacity to deliver 150 million gallons per day. They would thus be capable of passing a large quantity of water quickly from one reservoir to another, so that during storms, which occur sometimes on one portion of the Catchment Area and do not extend to the other, the surplus water, which otherwise would run to waste when a reservoir is full, would be passed on to those lower down. In this way it will be possible to obtain a greater benefit from the rainstorms over the whole area than would result from a series of disconnected reservoirs.

I estimate that the main ''Pressure tunnel'' from the Cataract Reservoir to Bankstown, together with the two branch tunnels, could be completed in five years, if the works were all being carried on at the same time, at a total cost of £3,761,468.

The tunnels connecting the reservoirs in the Catchment Area could be carried on from time to time as they were required, but those connecting the Cataract and Cordeaux, and the Avon should be commenced at once, so as to be completed at the same time with the dams for those reservoirs, namely, in 1920 and 1924. I estimate that the total cost of the 20½ miles of tunnel on the Catchment Area would cost £1,075,727.

The Woronora Scheme is of the greatest importance, as it would, when completed, be capable of conveying the drainage from 85 square miles of new country in every way similar to the present Catchment Area of the Upper Nepean and Cataract Rivers, into the existing canal.

The rainfall over this area is quite equal to that over the area above-named. The works will consist of a ten mile tunnel and two reservoirs, which, I estimate, could be constructed for £1,365,064. If the full benefit of these works is to be secured in 1923, when it may, perhaps, be sorely needed, they should be commenced not later than next year.

In the statement in Appendix I now submit for your inspection, I have set out in their proper sequence, the costs of the several works year after year for the next thirty years, which would have to be incurred if the Sydney Water Supply is to be placed upon a satisfactory and secure basis after the year 1924.

During the next seven years, from the present time, I have endeavoured to show that there may not be a sufficient reserve storage to meet a possible protracted dry period, and it is therefore obvious that the only way to make the position secure would be to commence the works earlier than I have shown, which would mean that the Avon Dam and the Woronora Tunnel should be commenced at once or otherwise with the least possible delay. We have already lost

seven years of valuable time, and there is therefore no other way to make up for it but to proceed in the manner I have indicated.

In order to confine the statement of costs of the various works and services within reasonable limits, I have converted the whole of such costs shown in the Table in appendix into pounds per day.

The cost of the water in Columns "J," "P," and "V" is given in pounds per million gallons, and as consumers have to pay for water at a rate of pence per thousand gallons, I have complied with that requirement in Columns "K," "Q" and "W."

Column "K" shows the total cost in pence per thousand gallons of the water delivered to Crown Street and Ryde by *gravitation only*. Column "Q" shows the total mean cost in pence per thousand gallons of the water delivered to Crown Street and Ryde by gravitation, *plus the total mean cost of pumping it to the higher zones.*

Column "W" shows from the year 1922, when pumping would cease, the total mean cost in pence per thousand gallons of all the works included in the costs shown in Column "Q," less the cost of the additional works of the Prospect Scheme shown in Column "E," less also the cost of pumping shown in Columns "M" and "N," plus the cost of all the work included under my proposal shown in Column "R."

Column "X" shows the excess or deficiency in the cost per thousand gallons when comparing the cost of the water delivered under my proposal shown in Column "W," with the cost of the water gravitated and pumped as shown in Column "Q."

An inspection of Column "X" shows that, notwithstanding the heavy expenditure which will be necessary for the

construction of the works connected with my proposal, over and above the expenditure which will have to be incurred if it is not adopted, the additional cost expressed in pence per thousand gallons would only amount to a small decimal above *one penny* per thousand gallons in the year 1922, and this would immediately drop to a little over 1/3rd of a penny per thousand gallons in the following year, owing to the stoppage of boosting and pumping the water.

Thereafter the decline in additional cost would continue until the year 1931-2, when the costs in Columns "Q" and "W" are shown to be equal. A saving would then commence, which would increase year after year until 1946-7, when the saving would amount to 0.386 of a penny per thousand gallons.

As the limit of my scheme would then have been reached, that is to say, the pressure tunnels would then be delivering water at their full capacity of 150 millions of gallons per day, any further increase in the daily consumption of water on the higher zones beyond that quantity would, of course, have to be pumped; but it should not be forgotten that the saving in the cost of pumping 150 millions of gallons daily would continue for ever.

I have added another column ("Y") showing the excess or deficiency in the cost, expressed in another way, namely, in *pounds sterling per annum*, which enables one to grasp the magnitude of the saving better than by the previous column.

It will be seen that in 1922, when the pressure tunnels would be ready to commence duty, the additional cost of my proposal would amount to £274,115.

Although the yearly additional cost from that time rapidly decreases, it still reaches considerable figures, namely, £419,385 in 1931, on which date the costs of the two Columns "Q" and "W" are shown to be equal.

Thereafter a saving would be effected, which would annually increase until 1942-3, when it will be seen that my proposal would pay for itself, inasmuch as the total savings would then have amounted to £419,385.

The saving would continue to increase until in 1946-7, the total clear profit would amount to £490,560. Thereafter, the profit would continue to increase at the rate of £125,560 per annum, resulting from the elimination of the costs shown in Columns "E," "M" and "N," equalling £835 per day.

I think it will be admitted that if these figures are correct, a good case has been made out in favour of very careful consideration being given to my proposal. The figures depend, of course, upon the question of the reliability of my estimates.

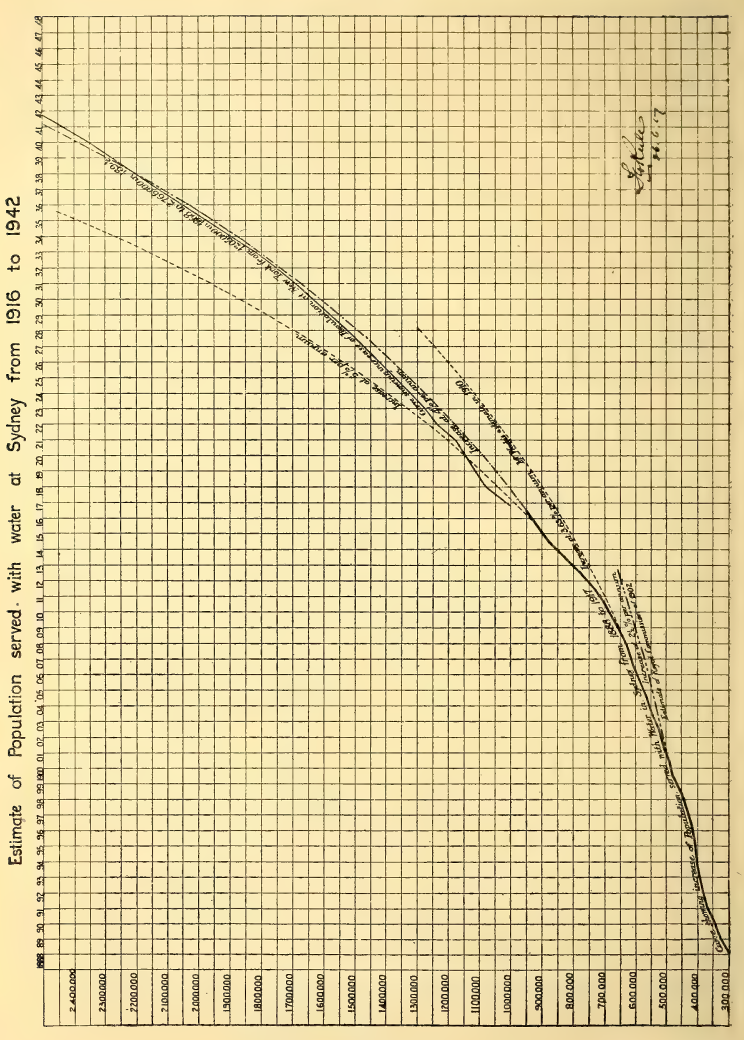
I may say that I have given the whole matter very close study, and my assurance may be accepted that a perfectly honest attempt has been made to arrive at the truth. The costs of the existing system are based on the figures given in the annual reports of the Water Board. Those relating to the construction of the various dams are based on the costs of works already constructed and of the Cordeaux Dam, as given in the Public Works Committee's reports, making a fair allowance for increased costs of labour and materials, and also for land resumptions, etc. The works I propose are all connected with tunnelling and as some of you may be aware, the whole of the alignment and construction of the tunnels on the existing system of the Sydney Water Supply were carried out by me, personally, or under my direction during 1880 to 1885 amounting to twelve miles in length, the longest being four and a half miles through the Hawkesbury Sandstone; it will, therefore, be perhaps admitted that I have had considerable experience in that class of work which is similar in every way to that

I propose. Having made liberal allowance for increased cost of prices in labour and materials since the existing works were constructed, I think it will be found that my estimates will not be far out; but even assuming that the proposed works would cost as much as 50 per cent. more than what I have estimated, my proposals are well worthy of adoption.

My estimate of the cost of pumping is based on the lowest prices shown in the Board's Annual Report for 1915-16. It may be interesting to state that since that time the cost of coal has risen to an extra 3s. 6d. per ton. It is not at all likely to decrease, and who can say, therefore, what it will amount to ten, twenty, or thirty years hence?

I have already referred to the fact that more than half the existing conduit is easily accessible on account of it being above the surface of the ground and the risk is therefore always present of possible interference, or, indeed, I may go so far as to say, complete dislocation of the supply, and where dependence must be placed upon coal as a means of generating the power required to raise the water to the higher levels, we are entirely at the mercy of those who foment strikes amongst the industrial unions.

If we compare the situation under these circumstances with the advantages that would be derived from a conduit located in such a manner as to eliminate all those risks, and which, once constructed, would be everlasting, would require no maintenance, and would moreover deliver the water in the same condition of purity in which it fell from the heavens upon the Catchment Area, we might well consider ourselves fortunate if the work would eventually pay for itself alone, without any profit whatever.



Estimate of Population served with water at Sydney from 1916 to 1942

Appendix to Paper on Sydney Water Supply

Low Level Gravitation Water (columns A–J)

Year	Population served with water increasing at 4 per cent per annum	Consumption in gallons per head per day	Consumption in gallons per day	Percentage of Water Pumped	Quantity of Water Pumped in gallons per day	A Cost of Prospect Scheme (Pounds per day)	B Est Cost of Dams on Catchment Area and of Winge-carribee (Pounds per day)	C Est Cost of Wingecarribee Tunnel (Pounds per day)	D Est Cost of Woronora Scheme (Pounds per day)	E Est Cost of addns to Prospect Scheme to deliver 75 million gallons per day to Crown St and also to Ryde (Pounds per day)	F Est Cost of Wallondilly Scheme (Pounds per day)	G Est Cost of filtering Wallondilly Water (Pounds per day)	H Est Cost of Boosting Water (Pounds per day)	I Est Total Cost (Pounds per day)	J Est Cost per million gallons (Pounds)
1915	878790	4086	35909589	6813	24465203	369	45						23	437	1217
1916	917990	4289	39380000	6237	24561306	373	45						25	443	1125
1917	950499	44	41821956	62	25929612	377	61			29			26	493	1178
1918	988519	46	45471874	623	28328977	381	77		25	59			29	571	12.56
1919	1028060	48	49346880	625	30841800	381	92		50	88			31	642	13.01
1920	1069182	50	53459100	628	33572315	381	108		75	118			34	716	13.39
1921	1111949	52	57821348	631	36485270	381	123		100	147			36	787	13.61
1922	1156427	54	62447058	634	39591435	381	139		125	177			40	862	13.80
1923	1202684	56	67350304	636	42834793	381	154		150	177				862	12.80
1924	1250792	58	72545936	639	46356853	381	170		150	177				878	12.10
1925	1300823	60	78049380	642	50107702	381	190		150	177				898	11.50
1926	1352856	602	81441931	645	52530045	381	211	8	150	177				927	11.38
1927	1406971	604	84981048	648	55067719	381	232	16	150	177				956	11.25
1928	1463250	606	88672950	65	57637417	381	253	23	150	177				984	11.09
1929	1521780	608	92524224	65.3	60418318	381	273	31	150	177				1012	10.93
1930	1582651	61	96541711	656	63331362	381	294	39	150	177	52			1093	11.32
1931	1645957	612	100732568	659	66382762	381	319	39	150	177	104			1170	11.61
1932	1711795	614	105104213	661	69473885	381	344	39	150	177	156			1247	11.86
1933	1780267	616	109664447	664	72817193	381	369	39	150	177	208			1324	12.07
1934	1851478	618	114421340	667	76319034	381	393	39	150	177	260			1400	12.23
1935	1925537	62	119383294	67	79986807	381	418	39	150	177	312			1477	12.37
1936	2002558	625	125159875	672	84107436	381	436	39	150	177	312			1495	11.94
1937	2082661	63	131207643	675	88565159	381	453	39	150	177	312			1512	11.52
1938	2165967	635	137538904	67.8	93251377	381	453	39	150	177	312	4		1516	11.02
1939	2252606	64	144166784	68	98033413	381	453	39	150	177	312	36		1548	10.74
1940	2342710	645	151104795	683	103204575	381	453	39	150	177	312	68		1580	10.46
1941	2436418	65	158367170	686	108639878	381	453	39	150	177	312	98		1610	10.17
1942	2533875	66	167235750	689	115225432	381	453	39	150	177	312	138		1650	9.87
1943	2635230	67	176560410	691	122003243	381	453	39	150	177	312	180		1692	9.58
1944	2740639	68	186363452	694	129336236	381	453	39	150	177	312	223		1735	9.31
1945	2850265	69	196668285	697	137077794	381	453	39	150	177	312	270		1782	9.06
1946	2984276	70	207499320	70	145249524	381	453	39	150	177	312	317		1829	8.81
	3033014	7015	213827512	7015	150000000							343		1855	8.67
1947	3082847	71	218882137	70.3	155874142	381	453	39	150	177	312	369		1881	8.59

Low Level Gravitation Water (K) — Low Level Gravitation Water Pumped (L–Q) — High Pressure Gravitation Water (R–Y)

Year	K Est Cost per Thousand gallons (Pence)	L Cost of Works and Machinery connected with Pumping (Pounds per day)	M Est Cost of Additions (Pounds per day)	N Est Cost of Pumping (Pounds per day)	O Est Total Cost of Pumped Water (Pounds per day)	P Est Cost per million gallons (Pounds)	Q Est Cost per Thousand gallons (Pence)	R Est Cost of High Pressure Scheme (Pounds per day)	S Est Total Cost of items marked A B C D F G L (Pounds per day)	T Est Cost of Pumping when Consumption exceeds 150 million gallons per day (Pounds per day)	U Est Total Cost of items marked R and S (Pounds per day)	V Est Cost per million gallons (Pounds)	W Est Cost per Thousand gallons (Pence)	X Excess or Deficiency when comparing Columns Q and W (Pence)	Y Excess or Deficiency in Pounds per Annum	
1915	2.921	28		87	552	15 372	3.689									
1916	2.699	28		88	559	14 195	3.407									
1917	2.829	33		108	634	15 159	3.638									
1918	3.014	37		118	726	15 965	3.832	89	667		756	16629	3.990	·0.158	10950	
1919	3.122	42		128	812	16 454	3.949	177	724		901	18 258	4.382	·0.433	32485	
1920	3.214	47		140	903	16 891	4.054	266	785		1051	19 659	4.718	·0.664	54020	
1921	3.267	47		152	986	17 052	4.092	360	839		1199	20 736	4.976	·0.884	77745	
1922	3.313	47		165	1074	17 198	4.127	448	897		1345	21 538	5.169	·1.042	98915	£274115 Excess cost when Pumping would cease
1923	3.071	47	3	178	1090	16 184	3.884	454	732		1186	17 609	4.226	·0.342	35040	
1924	2.904	47	7	193	1125	15 507	3.722	459	748		1207	16 637	3.992	·0.270	29930	
1925	2.761	47	10	209	1164	14.913	3.579	459	768		1227	15 720	3.773	·0.194	22995	
1926	2.732	47	13	219	1206	14.808	3.554	459	797		1256	15 422	3.701	·0.147	18250	
1927	2.700	47	16	229	1248	14 685	3.524	459	826		1285	15 121	3.629	·0.105	13505	
1928	2.663	47	20	240	1291	14 559	3.494	467	854		1321	14.897	3.575	·0.081	10950	
1929	2.625	47	23	252	1334	14 417	3.460	475	882		1357	14.666	3.519	·0.059	8395	
1930	2.711	47	26	264	1430	14.812	3.555	483	963		1446	14.977	3.594	·0.039	5840	
1931	2.788	47	29	276	1522	15 109	3.626	483	1040		1523	15.119	3.628	·0.002	365	£419385 Total Excess cost
1932	2.847	47	33	289	1616	15.374	3.690	483	1117		1600	15 223	3.653	-0.036	5840	
1933	2.897	47	33	303	1707	15.565	3.736	483	1194		1677	15.292	3.670	-0.066	10950	
1934	2.936	47	33	318	1798	15 713	3.771	486	1270		1756	15.346	3.683	-0.088	15330	
1935	2.969	47	33	333	1890	15.831	3.799	491	1347		1838	15 396	3.694	-0.108	18980	
1936	2.866	47	33	350	1925	15 380	3.691	491	1365		1856	14.829	3.559	-0.132	25185	
1937	2.765	47	33	369	1961	14.945	3.587	491	1382		1873	14.275	3.426	-0.161	32120	
1938	2.645	47	33	388	1984	14.425	3.462	491	1386		1877	13.647	3.275	-0.187	39055	
1939	2.577	47	33	408	2036	14 122	3.389	491	1418		1909	13 241	3.178	-0.212	46355	SAVINGS
1940	2.509	47	33	430	2090	13.831	3.319	491	1450		1941	12 845	3.083	-0.236	54385	
1941	2.439	47	33	452	2142	13.525	3.246	491	1480		1971	12 446	2.987	-0.259	62415	
1942	2.368	47	33	480	2210	13 214	3.171	491	1520		2011	12.025	2.886	-0.285	72635	£419385 Scheme pays for itself
1943	2.299	47	33	508	2280	12 913	3.099	491	1562		2053	11 628	2.791	-0.309	82855	
1944	2.234	47	33	539	2354	12.631	3.031	491	1605		2096	11 247	2.699	-0.332	94170	
1945	2.174	47	33	571	2433	12 371	2.969	491	1652		2143	10.896	2.615	-0.354	105850	
1946	2.115	47	33	605	2514	12 115	2.907	491	1699		2190	10 554	2.533	-0.374	118260	
	2.082	-		625	2560	11 972	2.873		1725		2216	10 363	2.487	-0.386	125560	
1947	2.082	47	33	641	2602	11.887	2.853	491	1751	16	2258	10 316	2.476	-0.377	125560	

£ 909 945 Total Savings in 1947
490 560 Clear profit, increasing yearly at the rate of £125 560

26. 6. 17

ON THE RESIN OF THE OUTER BARK OF *MELALEUCA UNCINATA.*

By Henry G. Smith, F.C.S.

[*Read before the Royal Society of N.S. Wales, August 1, 1917.*]

Some time back attention was directed to certain peculiarities shown by the outer bark of this *Melaleuca*, and material forwarded to the Technological Museum, Sydney, by Mr. E. Burgess of Cygnet River, Kangaroo Island, South Australia. Mr. Burgess stated that this thin inflammable bark could be obtained in large quantities, if suitable apparatus for collecting it were employed. He also pointed out that it appeared to be almost imperishable, as no alteration seemed to have taken place after exposure to the sun and the weather for at least twenty years. This species of *Melaleuca* is known as "Broombush" in Kangaroo Island, where it grows extensively on the wet clay flats, as well as on the high lands. The shrub in the moister positions becomes very dense, and practically free from other species, but on the higher land it is more sparsely distributed and intermingled with other plants and trees. The species is, however, not restricted to Kangaroo Island, but has a most extensive range, and occurs plentifully in the neighbourhood of Wyalong, New South Wales.

In 1907 a paper[1] was read before this Society, by Mr. R. T. Baker and myself, on the Essential Oil of *Melaleuca uncinata*, in which it was shown that an excellent "Cajuput" oil could be distilled from this species. The present investigation is thus a further addition to the economics of this Australian plant.

[1] The Australian Melaleucas and their Essential Oils, Part II.

The thin paper-like bark, or epidermis, entirely clothes the stems, and branchlets, and when dry peels off in thin semi-transparent sheets, without distinctive structure. The under bark is quite separate, splits longitudinally, and does not contain the resin to any extent. This inner bark gives a fair quantity of ash on ignition, and isolated crystals of oxalate of lime can be detected microscopically in the section.

When ignited at one end, a piece of the thin outer bark continues to burn like a candle until wholly consumed, giving a bright flame with a considerable amount of black smoke, and an odour of burning resin. It is evident how greatly this material would aid fires in the Australian bush where this *Melaleuca* grows.

The inflammable substance in this bark consists almost entirely of a resin, and only a small proportion of a vegetable wax was detected.

The presence of a resin in quantity is a most unusual occurrence in plants belonging to the natural order Myrtaceæ, and I have been unable to find but one previous instance of a true resin having been recorded for this genus; (Hartzer, Ber. 9, 314, in the leaves of *Eucalyptus globulus*).

Solereder refers to a statement by Möller (Rindenanatomie, pp. 344 – 347) that resin spaces occur in the secondary bast in *Eucalyptus viminalis* and *E. Stuartiana* as an improbable one, and that it required re-examination.

The outer bark of *M. uncinata* is reddish-brown externally with grey patches at places; the markings indicate a more or less concentric arrangement, and the bark can be peeled off in that way. The outer bark when removed from a stem 1 cm. diameter was only $\frac{1}{3}$ mm. thick, was semi-opaque, reddish-brown internally, and somewhat tough; the thickest bark in the bulk sample received was under 1 mm. After boiling in alcohol to remove the resin, the

bark was slightly swollen, and had the general appearance of sheet rubber without its elasticity.

Numerous specimens of *M. uncinata* from various Australian localities are in the Museum herbarium, and they all have this thin outer bark on the stem and twigs, which ignited readily and gave a similar odour in each case. This peculiarity is thus a constant feature with this species of *Melaleuca* throughout the whole range of its distribution.

Although nearly one-fourth of this thin outer bark consists of resin, yet a natural exudation of the resin has not been observed, although one might expect such to occur under abnormal conditions.

The resin, after extracting from the finely powdered bark with boiling alcohol and evaporating to dryness on the water bath, was of an orange-brown colour, semi-transparent, in thin pieces, very brittle, and easily powdered between the fingers. In general appearance it somewhat resembles ordinary shellac, but is less transparent and more brittle. The specific gravity was 1·135 at 15° C.

The resin was almost entirely soluble in alcohol, more so in ether-alcohol and readily in acetone. It was only slightly soluble in chloroform, the portion going into solution being principally the neutral bodies and not the acid resin. Benzene acted similarly to chloroform. Turpentine had little action even on continued boiling. The resin was only partly soluble in ethyl-acetate.

The resin was practically soluble in hot glacial acetic acid, remaining in solution when cold. On slow evaporation microscopic crystals were formed in quantity, the whole mass being more or less crystalline.

The resin was only slightly dissolved on boiling in a solution of borax.

The acetone solution makes a splendid cold lacquer for brass. It is slightly coloured with a yellowish tint, dries quickly, becomes very hard, adheres to metal with great tenacity, and has a brilliant lustre, probably this is one of the best uses to which the resin could be economically put. It could readily be extracted by the acetone direct from the finely powdered bark.

Substances extracted.

The bark was finely ground in a mill and passed through an 80 mesh sieve. The powder contained 3·82 per cent. moisture, and 1·89 per cent. ash. 10 grams of the powder were treated with ether in a soxhlet for six hours, when the amount extracted was 1·827 grams = 18·27 per cent.

The same amount of powder, when extracted for twelve hours, gave 20·6 per cent. The residue afterwards boiled in alcohol yielded 2·68 per cent. more, so that altogether 23·28 per cent. was extracted.

When dissolved directly in boiling alcohol, the amount extracted was equal to 23·22 per cent. When this was dried, powdered, and extracted with ether, the whole dissolved with the exception of 2·6 per cent. The greater portion of the freshly extracted resinous bodies was thus soluble in both alcohol and ether.

The Vegetable Wax.

The filtered boiling alcoholic extract on cooling deposited the wax in a flocculent condition. This was filtered off, purified from boiling alcohol, dissolved in ether and filtered. The substance remaining on final evaporation represented not more than about 0·1 per cent. of the amount first extracted. The wax was somewhat brittle after fusing, and melted sharply at 67 – 68° C. The outer portion of a stem in the green state was scraped, the powder boiled in alcohol and the wax prepared as above. It was identical

with the portion precipitated from the boiling alcohol of the powdered bark. It thus appears that the whitish patches on the exterior of the bark consist of a vegetable wax.

The Acid Resin.

The ether solution from the dry alcoholic extract was neutralised with alcoholic potash, the ether removed, the pasty resin-salt dissolved in water, and the solution extracted with ether to remove adhering substances. The aqueous solution was then heated and afterwards acidified with hydrochloric acid. The acid resin represented from 65 to 70 per cent. of the whole resin extracted. When dried and powdered it was of a light drab colour, becoming brown with alkalis; for this reason it could not be satisfactorily titrated as the end reaction was obscured.

The acid resin melted at 148 – 150° C., darkening at about 135 – 140° C., and was partly soluble in ammonia. The acid resin evidently consists of a single substance, as is indicated from the following analytical data:—

0·1428 gram gave 0·1192 H_2O and 0·3628 gram CO_2 = 69·25 per cent. C., and 9·272 per cent. H.

$C_{17}H_{28}O_4$ contains 68·88 per cent. C., and 9·452 per cent. H.

That this formula is probably the correct one is suggested from the results obtained with the silver salt, prepared from the neutralised resin by the addition of nitrate of silver in the usual way.

0·2048 gram silver salt gave 0·0551 gram Ag = 26·9%
0·1042 ,, ,, ,, ,, 0·0283 ,, Ag = 27·1%
$C_{17}H_{27}AgO_4$ contains 26·8 per cent. silver.

The alcoholic solution of this acid resin gives a deep green colour, and deep green coloured precipitate with ferric chloride. This reaction is also given with the original

resin, but the neutral bodies do not give it, so that it is peculiar to the acid resin.

Neutral Resins.

The ether extract from the resin-salt, when evaporated to dryness, consisted of a light coloured resinous substance of a brittle nature, which melted at about 125 – 130° C., but the melting point was not sharp, and it evidently was not a single substance. The alcoholic solution was bitter to the taste. The neutral bodies represent about one-fourth of the amount of the resins extracted.

Action of Nitric Acid.

Five grams of the powdered resin were treated with 40 c.c. nitric acid; dense fumes were at once formed in the cold. The solution was boiled one and a half hours until clear and brown fumes ceased to form. The whole was then evaporated almost to dryness on the water bath, the residue boiled in water, in which it was only partly soluble, and treated with potash. Although crystals of potassium picrate were not formed, yet the after treatment showed that picric acid or an allied substance was present in traces, as it was possible to dye wool yellow. The mass insoluble in potash was of a yellowish colour, and although scarcely soluble in potash, was soluble in hot soda solution, from which it was again precipitated by acids. It was evidently an oxidised product and not a nitro compound, as the test for nitrogen gave negative results.

In the bark residue small amounts of tannin substances, and a glucoside, hydrolised by boiling acid, were detected, but no other constituent of interest was found.

NOTES ON ACACIA, No. III.—EXTRA-TROPICAL WESTERN AUSTRALIA.

(WITH DESCRIPTIONS OF NEW SPECIES.)

By J. H. MAIDEN, I.S.O., F.R.S., F.L.S.

[*Read before the Royal Society of N. S. Wales, September 5, 1917.*]

Pungentes (Plurinerves).

I. A. XEROPHILA W. V. Fitzgerald, Journ. W.A. Nat. Hist. Soc., p. 8, (May, 1904). (Syn. *A. Fitzgeraldi* Pritzel, Engler's Bot. Jahrb. xxxv, 291, 1905).

Originally described from Bardoc, thirty miles north of Kalgoorlie. It has since been collected by Mr. Surveyor Anketell in Muir's Transcontinental Railway Survey, 1901 (Kalgoorlie, going east).

Pungentes (Uninerves).

II. ACACIA PRAINII n. sp.

Frutex parvus, erectus, glaber, pungens, 2 – 3′ altus, ramulis paullo angulatis; phyllodiis angusto-linearibus, pugioniformibus, nervo medio prominente, mucrone longo, acuto, non striato; capitulis in racemis axillaribus gracilibus, pedunculis fere filiformibus; floribus glabris, 5-meris ca. 20 capitulo; calyce angusto, fere lineare, corollæ dimidio æquilongo; petalis libris; pistillo laeve, nitente; legumine seminibusque non visis.

A free-flowering small, erect bushy glabrous shrub of two or three feet, prickly to the touch because of the pungent tips of the phyllodes; branchlets slightly angular.

Phyllodia about 3 cm. ($1\frac{1}{4}$ inch) long, narrow linear, thickish, rigid, pugioniform, with a prominent midrib, and a long sharp mucrone; not striate. There are usually two but sometimes three glands, which vary somewhat in regard to the distance from the base.

Flower-heads in slender axillary racemes, the peduncles almost filiform. Flowers glabrous, 5-merous, about twenty in the head, which is globular. Bracts at base of flowers not seen. Calyx narrow; almost linear, free, thin, half as long as the corolla. Petals free, thickened at the apex. Pistil smooth and shiny. Pods and seed not seen.

Southern Cross (J. H. M., October, 1909).

Named in honour of Sir David Prain, F.R.S., Director of the Royal Botanic Gardens, Kew, who has been most kind in assisting me with material of this genus.

The following specimens are referred to this species:—

1. A shrub six feet high, Jibberding, Watheroo Rabbit-proof fence, August, 1905, in flower only (Max Koch, 1030a, formerly mixed with and labelled 1030), is referable to this species. The specimens are not good, but the flowers appear to be smaller and with ciliate tips to the sepals.

2. Coolgardie, flowers only (H. Nathan, October, 1899, and L. C. Webster, 1900).

The structure of the flowers is the same as that of *A. Prainii*, although it appears to have fewer flowers (13 – 16) in the head, but it has longer and narrower phyllodes, and the varietal name *linearis* is therefore proposed for it.

If the phyllodes be alone considered, *A. Prainii* comes under Pungentes (Uninerves), and in that series would be placed near *A. sphacelata*, *A. genistoides*, and *A. incæquiloba*.

But its racemose inflorescence takes it to Uninerves (Racemosæ) where, however, it seems to have no close relations. Its position can be reconsidered when pods are available.

Affinities.

1. With *A. sphacelata* Benth. In *A. sphacelata* the phyllodes are smaller, narrower and not flattish.

2. With *A. genistoides* A. Cunn. In *A. genistoides* the midrib is scarcely if at all evident, and the phyllode is not flattened. The flower in *A. genistoides* is ciliate, typically spathulate and not linear.

3. With *A. inœquiloba* W. V. F. *A. inœquiloba* differs from *A. Prainii* in the phyllodes, which are less rigid, and have the central nerve less defined, less numerous phyllodes, which are slightly narrower and longer (4 – 5 cm.); tips curved.

The flower-heads are in racemes, each raceme having leafy bracts with ciliate margins, which spring from a peduncle not in the axil, but a little removed from it, along the rhachis. The flower-heads are slightly oblong in shape, whereas those of *A. Prainii* are globular. Flowers about 23 in the head. Sepals narrow. The petals have black hairs on the outside on the upper half.

4. With *A. heteroneura* Benth. This species has phyllodes generally similar in outline and a similar midrib, but the fine lateral nerves of this species are absent in *A. Prainii*. *A. heteroneura* is also few-flowered, has a broad calyx and a pubescent pistil.

Pungentes (Uninerves).

III. A. INÆQUILOBA W. V. Fitzgerald, Journ. Bot., L, 18, (1912).

This species is hitherto known only from R. Helms' specimens collected on the Elder Exploring Expedition, Victoria Desert, Camp 56, 19th September, 1891. The following specimens appear to be referable to it.

1. A shrub about four feet high, in flower only. Cowcowing, August, 1904 (Max Koch, No. 1030).

2. A shrub of three feet. In fruit only. Kellerberrin, November, 1907 (W. V. Fitzgerald).

Attention may be invited to the tendency of the flower-heads to be oblong in the type.

The Cowcowing specimens (1030) are inequilobed (as regards the calyx) but not so much so as the type.

The Kellerberrin specimens are in fruit, which may be described as follows, as the fruit has not been previously described. Straight or slightly curved, 5 or 6 cm. long (but not fully ripe), 5 mm. broad, margins slightly thickened, moniliform. Seed (not quite ripe), longitudinally disposed, with a broadish funicle once or twice folded terminating in large granular basilar arillus.

Affinities.

1. With *A. genistoides* A. Cunn. Mr. Fitzgerald's own unpublished remarks are "The foliage and general appearance are those of specimens of *A. genistoides.* It differs from that species in the bracteate peduncles, conspicuous differently shaped bracteoles, fewer mostly 4-merous flowers in the heads, markedly distinct calyx, and broader thin, unribbed petals."

2. With *A. Prainii* n. sp. It is not necessary to fully repeat the remarks under *A. inæquiloba* at p. 240. The two species present considerable resemblance, but the inflorescence is racemose in *A. Prainii* and the flower-heads globular, while they are slightly oblong in *A. inæquiloba,* which also possesses leafy bracts, and also long black hairs on the petals, neither of which characters occurs in *A. Prainii.*

Uninerves (Triangulares).

IV. Acacia Rendlei n. sp.

Frutex spinosus, glaucus, $2\frac{1}{2}'$ altus; phyllodiis sub-triangularibus vel irregulariter trapeziformibus, ca. 7 mm. longis, apice ca. 7 mm. latis, phyllodiis plerumque spinis tenuibus, flexibilibus, brunneis, stipularibus ca. 1 cm. longis suppletis; phyllodiis duobus nervis

principalibus, uno nervo inferiore margini approximato et in mucronem acutem terminante, altero e basi phyllodiæ in marginem dorsalem terminante; nervis minoribus ex nervis principalibus provenientibus; floribus in capitulis solitariis, axillaribus, globosis, pedunculis filiformibus 1 – 1·5 cm. longis; calyce profunde lobato, hirsuto, corolla ca. triplo æquilongo; petalis partim disjunctis, glabris; pistillo longo, laeve; legumine seminibusque non visis.

A spinous glaucous shrub of two and a half feet. Phyllodes sub-triangular to irregularly trapeziform, about 7 mm. long and about as wide at the top; the phyllodes largely replaced by thin, flexible brown stipular spines up to 1 cm. long. The phyllodes have usually two main nerves, one nearly following the lower straight margin, and terminating in a sharp mucrone, while from the base of the phyllode usually springs a second thinner nerve terminating in the dorsal margin. From both nerves some smaller nerves proceed.

Flowers in single axillary globular heads, about thirty in the head, on filiform peduncles of 1 – 1·5 cm. Flowers 5-merous; calyx deeply lobed and hairy, about a third as long as the corolla. Petals divided part of the way down; glabrous. Pistil long and smooth. Pod and seeds not seen.

Type in clayey sand near Fraser Range, 2nd November, 1891, Elder Exploring Expedition (R. Helms).

Named in honour of Dr. Alfred Barton Rendle, F.R.S., Keeper of the Department of Botany of the British Museum, London, who has been most kind in assisting me with material of this genus.

Referable to this species is a specimen from Coolgardie, 1900 (L. C. Webster).

Affinities.

1. With *A. strongylophylla* F.v.M. In *A. strongylophylla* we have a longer, larger, entirely glabrous flower; the calyx is very slight, with a spoon-shaped apex to each sepal. The petals are divided one-third of the way down, and the

calyx is two-thirds as long as the corolla. In *A. strongylophylla* also, the phyllode is less triangular or trapeziform, and has only one main nerve.

At the same time it seems to me that in habit of the plant, in the presence of stipular spines, and prominent mucrones, in the general shape of the phyllodes, the new species presents an obviously very close affinity to *A. strongylophylla.*

Mueller (Fragm. viii, 227) hesitated about the position of *A. strongylophylla.* He placed it in the neighbourhood of *A. idiomorpha* A. Cunn., *A. pyrifolia* DC., *A. anceps* DC., all of which belong to the Series Uninerves, but to the Sub-series Armatæ, Racemosæ, Brevifoliæ respectively. I have already suggested that the place of *A. Rendlei* is with the Sub-series Triangulares.

2. With *A. dilatata* Benth. In this Sub-series it exhibits obviously close affinity to *A. dilatata*, in the shape, size and venation of the phyllodes and in the pungent mucrones. *A. dilatata* differs in the comparative fewness and small size of the spinescent stipules, and in the hispid covering. The flowers of *A. dilatata* are hispid all over (not the calyx only, as in *A. Rendlei*), and the calyx is half as long as the corolla.

3. With *A. Luehmanni* F.v.M. There is a general similarity in regard to the phyllodes of the two species which is drawn attention to as matter of convenience. The stipular spines are quite small and the structure of the flowers is quite different. The phyllodes are plurinerved, that is to say, one is (or occasionally two are) not dominant, as in uninerved species.

The placing of *A. Luehmanni* F.v.M. in the Plurinerves (Triangulares) draws attention to the fact that the boundary line between that Series and the Uninerves (Triangulares) rests on minor and not larger details. The Series of

Bentham have been of great value, but in view of the additional knowledge we have acquired concerning Australian Acacias during the last half century, the broad classification requires amendment in certain directions.

Uninerves (Brevifoliæ).

V. A. TYSONI Luehmann, Vict. Nat., xiii, 112 (1896).

Following are supplementary notes:—

(1) Called by the settlers "Limestone Wattle" at Mount Narryer, Murchison River (Tyson).

(2) "Twelve feet high." Nannine (W. V. Fitzgerald).

(3) 1·3–2 metres high. Cowcowing (M. Koch, No. 1666).

This is probably correct, but No. 3 specimen consists of little more than phyllodes.

Uninerves (Racemosæ).

VI. A. ÆSTIVALIS Pritzel, in Engler's Bot. Jahrb. xxxv, 300 (with a figure), was described as a small glabrous tree, about three metres high, and was recorded from near Moora and near Watheroo. Mr. W. V. Fitzgerald collected it, a shrub of 8—10 feet, Cunderdin, 104 miles east of Perth. Dr. Stoward now sends it from cultivated land near Baandee Railway Station (149 miles east of Perth). Land of best quality, Salmon Gum and Gimlet. A strong growing shrub of six feet high, spontaneous. He also sends it from Kunonoppin (No. 68). Mr. L. C. Webster collected it at Coolgardie, 351 miles east of Perth.

Uninerves (Racemosæ).

VII. A. SCLEROSPERMA F.v.M.

(Syn. *A. spodiosperma* F.v.M. and *A. leucosperma* F.v.M.)

(1) *A. sclerosperma* F.v.M. in Wing's Southern Science Record ii, 150, (July, 1882).

I have not seen the type, which is "near the Gascoyne River, Oliver Jones," but I have seen a specimen labelled

A. spodiosperma from the Gascoyne River, Mrs. Gribble, 1886, given me by Prof. Ewart, and also a specimen labelled *A. sclerosperma* F.v.M. (by Mueller) in pod only, Nickol River, W.A. (A. Forrest), given by Mr. Luehmann to me in 1897. I consider them, from the material available, to be identical with (2) and (3).

In the original description of *A. sclerosperma*, Mueller says "Foliage resembling that of *A. dentigera* (misprint for *dentifera*) and *A. pycnophylla.*

(2) *A. spodiosperma* F.v.M. type, Proc. Linn. Soc. N.S.W. iii, (2nd Ser.) 164 (1888). Near Lake Austin, W.A. H. S. King. Considered by Mueller at the time to be aff. *A. scirpifolia* and *A. calamifolia*, but now, I think correctly, placed near *A. salicina* Lindl.

(3) *A. leucosperma* F.v.M. MSS. Quoted by Pritzel in Engler's Bot. Jahrb., xxxv, 302, (1905), and described by him as F.v.M. ined. and Pritzel. See also a note on it by Ewart and White, Proc. Roy. Soc. Vict., xxii, 91 (1909).

I offer a translation of Diels and Pritzel's remarks, as the species has been otherwise only imperfectly described.

A. leucosperma F.v.M. ined. et E. Pritzel n. sp.

In the Melbourne Herbarium I found a specimen collected by H. S. King near Lake Austin, named by F.v. Müller *A. leucosperma* n. sp. but never publicly described. From more complete specimens collected by us this species may be described :—

A shrub or tree up to 3·5 m. high, very glabrous, the young parts often glaucescent. Phyllodes spreading, linear, obtuse at the apex, subtruncate or curved back, somewhat thick, without nerves except for the prominent middle nerve, pale or glaucous green. Heads solitary in the axils or shortly (up to 3), racemose, peduncles conspicuous, heads conspicuous about 20 flowered. Flowers 5-merous, calyx shortly truncate, petals smooth. The pod when quite ripe having woody valves strongly arched above

the seeds, dark brown, narrowed in breadth between the seeds about towards the middle, seeds more or less globular, dark yellow, shining. Unripe pods somewhat smooth, glaucescent. Phyllodes 5 – 8 cm. long, 2 – 4 mm. broad. Peduncle 1 – 2 cm. long. Ripe pod 10 – 12 cm. long, up to 13 mm. broad above the seeds. Ripe seed ·5 – ·8 mm. in diameter. Habitat in the Austin district near Carnarvon at Shark's Bay, most frequent in the sandy muddy sea coasts, flowered in the month of August (D. 3653). There is an incomplete indeterminate specimen of the same species in the Berlin Herbarium, collected by Gaudichaud at Shark's Bay about 1830.

The species bears a strong affinity to *A. salicina* Lindl., and is not certainly distinguished from that species except in the fruits and seeds (which are very distinct); it differs, however, in having much narrower phyllodes.

The late Dr. A. Morrison collected it at Onslow, Ashburton River, so that it is recorded from Shark's Bay (Carnarvon), round the coast as far as Nickol Bay, but it has not yet been recorded from the Northern Territory.

VIII. A. Blakelyi n. sp.

Frutex parvus, suberectus, ramulis rotundatis, paullo curvatis, glabris; phyllodiis lineari-lanceolatis, 10 – 11·5 cm. longis, 7 – 8 mm. latis, rectis v. paullo falcatis, crassiusculis, marginibus incrassatis, costa media prominente, duabis venis parallelibus minus prominentibus, uno utroque latere costae mediae; costa media glandulam phyllodiae basin versus gerente; capitulis paucis in brevibus racemis, floribus numerosis, 5-meris; calyce tenue, non ciliato, truncato, plus triplo petalis aequilongo; petalis basi facile disjungentibus; pistillo laeve; legumine lineare, paullo contorto, moniliforme, phyllodiis longiore, marginibus pallidis, seminibus angustis, funiculo bis curvato et in arillum paullo inflatum terminante.

A small sub-erect shrub. Branchlets rounded and slightly curved, glabrous. Phyllodia linear-lanceolate, 10 – 11·5 cm.

(4 – 4·5 inches) long, 7 – 8 mm. broad, straight or slightly falcate, the apex a rather sharp point, texture rather thick, margins thickened, with a prominent midrib, and two less prominent, but usually quite distinct, parallel veins, one on each side of the midrib. One prominent gland on the midrib, an unusual situation, near the base of the phyllode. Flower-heads few, in short racemes, on peduncles of about 1 cm., with numerous 5-merous flowers.

Calyx very transparent, not ciliate, without midribs, truncate, rather more than one-third as long as the petals; the petals easily separating to the base, and without midribs. Pistil smooth.

Pods linear, slightly twisted and moniliform, longer than the phyllodes, with pale-coloured, smooth, thickened valve-margins. Seeds narrow, the funicle usually bent twice and terminating in a slightly swollen arillus.

Minginew, in flower and fruit. Type. (J.H.M., Oct. 1909).

The following specimens are referable to this species:—

1. Minginew, in flower only, and phyllodes narrower than the type (W. V. Fitzgerald, September, 1903).

2. Yandanooka, south of Minginew, in flower only. (A. Morrison, September, 1904).

3. Northam, in flower only (J. H. Gregory, 1900).

4. Geraldton, in flower and fruit, with phyllodes narrower than the type. (Dr. J. B. Cleland, 1907).

In honour of William Faris Blakely, Botanical Assistant, Botanic Gardens, who has given me most valuable assistance in the elucidation of this genus.

Affinities.

1. With *A. bivenosa* DC. Perhaps its closest affinity is to *A. bivenosa* DC., and particularly to that form of it originally named *A. xanthina* by Bentham. *A. Blakelyi* is primarily uninerved, although the secondary veins are some-

times almost continuous, and thus may simulate a pluri-nerved phyllode. Similarly the "bivenose" character of *A. xanthina* is not always present.

As a rule the phyllodes of *A. Blakelyi* are narrower than those of *A. bivenosa* (and even of the narrower *A. xanthina* form), while the conspicuous gland of the former is not present in the latter species.

The flowers of the two species resemble each other a good deal in structure, but the pods are very different, those of *A. bivenosa* considerably resembling those of *A. salicina*.

2. With *A. rostellifera* Benth. There is no doubt that it has often been confused, on general resemblances, with *A. rostellifera* Benth. In that species we have one-nerved phyllodes, with two to four glands on the *edge* of the phyllodes, axillary flowers, calyx finely ciliate and a hairy pistil. It is sharply separated from *A. Blakelyi*, which has a gland in an unusual position,—on the midrib.

As regards fruits, while I have excellent ones as regards *A. Blakelyi*, I have only fruits from a cultivated shrub of *A. rostellifera*, the spontaneous specimens corresponding to the seeds, having been misplaced. I therefore speak with diffidence in regard to them, since the pods of *A. rostellifera* have not been described. The cultivated pods referred to have valves very much wider than those of *A. Blakelyi*, while the arillus is smaller.

IX. A. PYRIFOLIA DC. var. MORRISONI, var. nov.

Globe Hlll, Ashburton River (banks of river). (Dr. A. Morrison, 6th October, 1905).

In a short paper in the Scottish Botanical Review, April, 1912, p. 98, Dr. Morrison described this form as a new variety, but omitted to give it a name, and I rectify this omission by naming it after our lamented friend.

Compared with the type, it has narrower and smaller phyllodes, and is less glaucous. The pods are narrower and smaller, the seeds more globular and the funicle is about half the length of that of the typical form. Dr. Morrison describes the funicle in the variety and it varies in *A. pyrifolia*.

Plurinerves (Nervosæ).

X. A. MULTILINEATA W. V. F., in Journ. W. A. Nat. Hist. Soc., 13 (May, 1904).

The pods have not been described. The following is from Mr. Fitzgerald's MSS., and the pods were collected at Kellerberrin in November, 1907.

"Pod linear, torulose, compressed, tomentose, seeds longitudinal, ovate, dark brown, funicle short, terminating in a pale-coloured cupular basilar arillus."

Julifloræ (Rigidulæ).

XI. A. CHISHOLMI Bail., in Queensl. Agric. Journ. IV, 47 (1899).

Manutarra, Ashburton River, A. Morrison, 4th October, 1905. In fruit only.

This seems to be conspecific with *A. Chisholmi* Bailey, a species hitherto only known from Northern Queensland. It differs slightly from the type in the rather more curved pod, and in the depression of the seeds, which is not so deep in the type.

The specimen appears to be taken from a well developed plant. *A. Chisholmi* approaches some specimens of *A. linarioides* Benth. closely. The chief differences are in the more numerous phyllodes, which are obscurely one-nerved, and the narrower pods of the latter.

Julifloræ (Rigidulæ, but closer allied to *A. aneura*.)

XII. A. CRASPEDOCARPA F.v.M., Melb. Chem. and Drugg., New Ser. ii, 73, 1887. (Syn. *A. euphleba* W. V. F.)

The co-types came from Lake Austin, H. S. King, and between Yuin and the Murchison River, Ernest Giles. (To quote more than one specimen as a type is to be deprecated, and has often led to uncertainty).

(1) Mr. I. Tyson, Mount Narryer, Murchison River, sent it to the late Mr. R. Helms in 1897 with the note "The native name is "Turla." Settlers sometimes call it "Round-leaf Mulga."

(2) *A. euphleba* W. V. Fitzgerald, in Journ. W. A. Nat. Hist. Soc. (May, 1904), was described from a small leaved form of *A. craspedocarpa* in young bud and without pods. Type of *A. euphleba* from near Milly's Soak, near Cue, Murchison River district.

(3) This specimen (No. 2) may be identical with "A plant with smaller phyllodia, obtained near Stuart's Range by Mr. Winnecke, may belong to *A. craspedocarpa* also; the specimens however are in a young flowering state only."

(4) Diels and Pritzel in Engler's Bot. Jahrb., xxxv, 304, with fig. 35a, also found it in the Austin district.

(5) A dense, sturdy shrub of 6 – 8 feet. In both flower and fruit. Cue to Milly's Soak (J.H.M., September, 1909). The flowers, the only ones I have seen, are sub-spicate.

(6) Tampa, 120 miles north of Kalgoorlie, in early fruit (J. F. Jutson, No. 9, July, 1915).

Mueller says "The phyllodia of our new species are not dissimilar to those of *A. translucens*, though generally broader, but there is a wide difference in flowers and fruit; of real affinity is *A. lysiphlœa*, from which however, as well as from nearly all other species, it is really distinguished by its remarkably broad-margined fruit, reminding in that of *A. sericata*."

Fitzgerald gives the affinity as *A. dictyophleba* F.v.M., doubtfully, basing it on the venation of the phyllodes.

Diels and Pritzel (*op. cit.*, p. 305) give the affinity as *A. aneura* F.v.M., based on the pods, and I independently arrived at the same conclusion. Their figure of the pod might be better, particularly as regards reticulation, but the yellow coloured, varnished, reticulated pod is strikingly like that of *A. aneura*, particularly of Western Australian plants of the species.

Julifloræ (Stenophyllæ).

XIII. A. Grasbyi n. sp.

Frutex divaricatus ad 10′ altus. Phyllodiis teretibus 4 – 5 cm. longis, minute striatis, tomento breve tectis. Floribus 5-meris, spicis ca. 2 cm. longis, pedunculis subaequilongis. Calyce truncato, magno, basi hirsuto. Petalis glabris, dimidio longitudinis conjunctis. Pistillo pruinoso. Legumine 8 – 11 cm. longo, 1 cm. lato, applanato, inter semina incincto, valvarum marginibus incrassatis. Semine applanato, fere oblongato, fusco, funiculo longo, applanato, rugoso, in arillum parvum, rotundatum, rugosum terminante.

A divaricate shrub up to about 10 feet high, and usually nearly as broad as high. Phyllodes terete, 4 – 5 cm. long, minutely striate when seen under a good lens, covered with a fine, short tomentum. Flowers 5-merous, in spikes, about 2 cm. long, on peduncles nearly as long. Bract long, capitate or spathulate, stipe hairy. Calyx large, truncate, hairy at the base. Petals glabrous, united about half way up. Pistil hoary.

Pod straight or curved, 8 to 11 cm. long, up to 1 cm. wide, flattish, constricted between the seeds, the valves with thickened edges, with dull or waxy lustre, with almost transverse markings or fissures on the outside of the valves, and very oblique ones on the inside through the contraction of the membrane.

Seed flattish, oblong, nearly 9 mm. long, colour brown, with a long white thin, flattish, wrinkled funicle, terminating without folds in a small rounded wrinkled arillus.

Type from the Cue-Milly's Soak road (J. H. M., October, 1909). I have taken this as the type, as I have a number of specimens from this locality; I have compared the others quoted, and do not find any differences from the type.

Named in honour of William Catton Grasby, Agricultural Editor of the "Western Mail," in recognition of his work, extending over a number of years, in diffusing a knowledge of the indigenous flora of Western Australia.

In addition to the type-specimens of *A. Grasbyi* I have small specimens of the following, belonging to the same species:—

1. Mount Narryer, Gascoyne River to Murchison River. In flower only (Isaac Tyson, 1898).

2. Murchison Goldfields (W. V. Fitzgerald, September, 1903. No flowers or fruit).

As regards No. 1, on 25th September, 1914, a specimen belonging to the late Mr. R. Helms, came into my hands. It bears the following label in Mr. Isaac Tyson's handwriting (Mr. Tyson was a friend of Mr. Helms):—" No. 9, *Acacia palustris.* Seeds much liked by sheep, used as food by the natives. "Cogada" is the native name."

Coming to No. 2, the following two paragraphs are from Mr. W. V. Fitzgerald's MSS.:—

1. "*A. cyperophylla* F.v.M. Shrub to a tree of 30 feet; trunk to 10 feet, diam. to 1 foot; bark reddish, rather rough, and curly; timber almost black, hard and rather heavy. Vernacular name 'Minnie Ritchie.'" Then follows a portion which is a copy of a passage by him in Journ. W. A. Nat. Hist. Soc. 2, Pt. i, p. 51 (1904).

2. "*A. palustris* J. G. Luehmann. Erect shrub to a tree of 20 feet; trunk and branches very tortuous, the former to 6 feet, diam. to 1 foot; bark reddish-brown, rather rough and curly; timber very dark, hard and heavy. 'Snakewood.'"

A clue to the identity of the above two species (in Mr. Fitzgerald's mind), is given in the following specimen (phyllodes and twigs only, but the material is quite unmistakable), labelled by him:—

"*Acacia cyperophylla* F.v.M. (with *cyperophylla* struck out and *palustris* substituted). Erect with crooked stem and curly bark, 10 feet high. 'Snakewood.' Murchison Goldfields, September, 1903."

What the plant is, described in paragraph one as *A. cyperophylla*, one cannot say. Certainly *A. Grasbyi* in part, but certainly not the true *A. cyperophylla* F.v.M., see Part LX of my "Forest Flora of New South Wales."

Diels and Pritzel say, "*A. palustris* Luehmann (nomen ineptum). Shrub up to 2·5 metres high, the bark coming away in twisted or curly flakes. In the Austin district near Cue, in muddy and stony soil. Flowering in June (D. 3276). (Engler's Bot. Jahrb. xxxv, 308)." *A. Grasbyi* is doubtless referred to.

The new species has therefore been confused with *A. cyperophylla* F.v.M. and *A. palustris* Luehmann. *A. Grasbyi* appears to be closest to *A. cyperophylla* F.v.M., a species I have carefully defined and illustrated in Part LX of my "Forest Flora of New South Wales." I will take the opportunity of indicating the principal differences between *A. Grasbyi* and both species.

A. cyperophylla is a broom-like bush; *A. Grasbyi* is more spreading and round-headed. The phyllodes of *A. Grasbyi* are short, averaging 4 – 5 cm. long, while those of *A. cyperophylla* are 15 – 25 cm. long. The flower-spikes have much longer peduncles than those of *A. cyperophylla*. The flowers do not differ in important characters from those of *A. cyperophylla;* these differences may be stated as follows: The calyx is rather larger in *A. Grasbyi*, and is hairy at the base. The petals of *A. Grasbyi* are united about half

way up, and are sometimes reflexed. Pistil smooth or hoary. The pods of *A. cyperophylla* are thinner and smaller than those of *A. Grasbyi*, but there is undoubtedly affinity between them.

The more important differences between *A. Grasbyi* and *A. palustris* appear to be as follows:—The phyllodes of the former are 4 – 5 cm. long, those of the latter 8 – 15 cm. long and much more markedly striate, and somewhat thinner. The spikes of *A. Grasbyi* have long peduncles; those of *A. palustris* are shortly pedunculate. The species are sharply separated by the truncate calyx of the former, as compared with the spathulate sepals of the latter.

The original type-specimen of *A. palustris* alone is known, and it would be desirable to obtain additional material of it and field-notes.

XIV. A. LONGIPHYLLODINEA n. sp.

Frutex crassus, rigidus, 6 – 8′ altus, caule glauca. Phyllodiis omnino glabris, fere 38 cm. longis, rigidissimis, teretibus crasse striatis, aliis costis prominentioribus quam aliis. Spicis plus quam 2 cm. longis, pedunculo 1 cm. Floribus 5-meris. Calyce truncato vel semi-truncato, paulo lobato, corolla plus dimidio aequilongo, apicibus crassatis, paucis nerviis sparse hirsutis. Petalis plus dimidio longitudinis conjunctis, glabris. Pistillo laeve. Leguminibus seminibusque non visis.

A coarse wiry, rigid, glaucous stemmed shrub of six to eight feet. Phyllodes quite glabrous, nearly 38 cm. (15 inches) long, very rigid, terete, coarsely striate, some ribs more prominent than others. The attachment to the branchlet not wrinkled, but decurrent and not articulated.

Flower-spikes more than 2 cm. long, with a peduncle of 1 cm. (about $\frac{3}{8}$ inch). The flowers closely packed in the spike and 5-merous. Bract long and narrow with hairs and a capitate head. Calyx truncate or semi-truncate,

slightly lobed, reaching about two-thirds up the corolla; tips thickened, long scattered hairs on some of the nerves and tips, edges ragged. Petals united two-thirds up, glabrous. Pistil smooth.

Pods and seeds not seen.

Jibberding, and Lake Monger, Victoria district. Growing on sand-plains. September, 1905 (Max Koch, No. 1341). In flower. (Distributed by Mr. Koch as *A. cyperophylla* F.v.M.).

The closest affinity of this species is to *A. cyperophylla*, and the differences may be indicated as follows:—

The phyllodes of *A. longiphyllodinea* are even more rigid and coarse than those of *A. cyperophylla*, and are up to half as long again. They are entirely glabrous, deeply grooved and ribbed. Some ribs stand up more prominently than others. There is an absence of the constricted base as seen in *A. cyperophylla*, the phyllode broadening a little at the base, and becoming decurrent, with the grooves and ridges continuous. Branchlets glaucous. The peduncles are 1 cm. long, those of *A. cyperophylla* are shorter.

The flower spikes of the latter species are shorter.

The truncate calyx of *A. longiphyllodinea* reaches about two-thirds up the corolla; (half-way in *A. cyperophylla*). The calyx is more definitely nerved than in *A. cyperophylla*, and it has longish scattered hairs.

[Jibberding is just east of the 120 mile peg, north of Cunderdin, on the East Goldfields Railway. The south end of Lake Monger commences about four miles north of Jibberding, about three miles east of the 124 mile, and extends north for about 40 miles parallel to Rabbit-proof fence (Watheroo section), and thence north-east another 30 odd miles. The camp known as Lake Monger would be situated to the west of the fence, opposite the 141 mile,

and about 21 miles north of Jibberding. This Lake Monger is not to be confused with a Lake Monger in the Perth district.]

XV. A. RAMULOSA W. V. Fitzgerald, in Journ. W.A. Nat. Hist. Soc. No. 1, p. 15 (May, 1904).

This Western Australian species which has long been confused with *A. brachystachya* Benth., I have figured and described it in Part LXI of my "Forest Flora of New South Wales." I refer my readers to that work for details as to synonymy, localities, etc.

XVI. A. LINOPHYLLA W.V.F., Journ. W. A. Nat. Hist. Soc. 16, (1904).

Described without flowers, and the affinity given as *A. xylocarpa* A. Cunn., on the pods. Type from Mount Magnet. A label of Mr. Fitzgerald's gives the additional localities of Nannine and Cue.

A specimen from Isaac Tyson, about 1897, from Mount Narryer, Murchison River, has the label "No. 50, one of the principal food seeds of the natives. Name 'Burgedur.' Settlers' name is 'Wanderry Mulga'."

Cue (W. D. Campbell, June, 1902; J. H. M., October, 1909).

This pungent phylloded Acacia with succulent pods has the pods suspended vertically like tallow candles hanging by their wicks, giving the shrub or tree a singular appearance. The pods are quite straight. Around Cue the plant is a tall shrub, beyond Yalgoo, going west, it becomes a tree of say 20 feet, with a stem of six inches and more.

The flowers are undescribed, and may be described as follows:—Flowers in nearly sessile spikes. Floral bracts thick and short. Calyx divided nearly to the base; has a few hairs. Calyx about a third as long as the corolla.

Corolla united two-thirds of the way up, glabrous. Pistil tomentose.

The affinity of this species both in flowers and fruits is with *A. ramulosa* W. V. F.

XVII. A. EPHEDROIDES Benth.

A. TRATMANIANA W.V.F. A. FILIFOLIA Benth.

Those who have carefully studied *A. ephedroides*, described without ripe fruit, do not need to be reminded that it is in an unsatisfactory state. Mueller declined to touch it in his Iconography, and no recent writer has critically dealt with it and its affinities. Following is a translation of the original description of *A. ephedroides.*

"Glabrous, branchlets terete; phyllodes elongated-subulate, somewhat compressed-terete, uncinate-subulate at the apex, very finely striate, spikes shortly cylindrical, dense, solitary or in twos, sessile. It has the habit and phyllodes of *A. calamiformis.* The flower-bearing spikes about ½ inch long, shortened before the flowering, amentiform with crowded imbricate flowers. Cape Porteray, *Fraser*, Swan River, *Preiss.*" Bentham in London Journ. Bot. i, 370, (1842).

It will be seen that specimens of Fraser and of Preiss were described. I have not seen a specimen of Fraser, but I have of Preiss, which must be taken as a co-type, and it is a very hairy form. It is quoted by its number (974) in Bentham's amended B. Fl. ii, 399, description.

Preiss says of it that it was collected on this (Perth) side of "Halfway House, Darling Range, 13th September, 1839." It is described by him in language of which the following is a translation:—

"Shrub of 8 feet. Branches somewhat compressed, obtuse-angled, the young shoots with a minute, ashy pubescence. Spikes oblong in one specimen, scarcely half an inch long, in another (but entirely similar) almost globose."

It may be described as follows:—

Phyllodia grooved, with a few scattered hairs; more on the tip, flattened. Flowers in short spikes ($\frac{1}{2}$ inch), peduncle covered with short white hair. Rhachis silky pubescent, 5-merous. Floral bract large, covered with hair. Calyx lobed half way down, covered in soft hair, half as long as the corolla. Petals smooth, separating about half way down, generally recurved, and with a slight midrib. Pistil covered in a thick mat of hair.

I have also seen Drummond's Fifth Collection, No. 2, which I understand was also collected on the Darling Range. This specimen, collected in 1849, could obviously not have been seen by Bentham when penning his original description of 1842, but he includes it in his amended description of B. Fl. ii, 399. The present specimen, as compared with Preiss's No. 974, shows the following differences:—

No. 974 is silky hairy everywhere, except in the adult foliage, and this silky hairiness extends to the floral bracts. The phyllodes are longer and more deeply grooved, and its calyx-lobes are pronounced, while the calyx-tube is almost truncate in Drummond's specimen. Floral bracts stipitate in Preiss's specimen and foliaceous in Drummond's No. 2. The latter specimen may be thus described.

Phyllodia terete, flexuose, smooth, more lined than grooved. Flowers in ovoid heads, sessile; rhachis glabrous, 4-merous. Floral bract hoary. Calyx truncate, lobed, with minute points, glabrous. Petals smooth, much thickened at the tips. Pistil hairy.

Pods in both cases unknown. I trust that Perth botanists and collectors will make satisfactory collections and notes of Darling Range (and indeed other localities) specimens believed to be *A. ephedroides*.

The *A. ephedroides* of Fig. 35 of Diels and Pritzel, Engler's Jahrb., xxxv, 306, shows a rather rigid plant with

flowers more distinctly spicate. I have not seen the plant figured, and therefore suspend my judgment concerning it.

The late Dr. A. Morrison, in the "Scottish Botanical Review" for April, 1912, p. 99 gave a description of the pods of *A. ephedroides* (Kunonoppin, F. E. Victor). I have not seen them, and the specimens should be re-examined.

The following specimen (Minginew, W. V. Fitzgerald, September, 1903) is temporarily attached to *A. ephedroides*, pending the receipt of pods and further information. It appears to differ from *A. ephedroides* in the young phyllodes which are terete and covered with a close white tomentum. The lobing of the calyx is also much more pronounced than in typical *A. ephedroides*.

Phyllodes when young, weak, covered in a close white tomentum; when mature smooth, and lined rather than grooved as in *A. ephedroides*. Flowers in short ovoid spikes half an inch long, very irregular, 5-merous, and sometimes 4-merous. Peduncle short and covered in white hair. Rhachis hairy. Floral bract capitate or thin, hairy. Calyx more or less deeply lobed, lobes rather narrow, fully half as long as the corolla, hairy. Petals united half way up when young, free when mature, smooth. Pistil hairy. Pods not seen.

A. TRATMANIANA W. V. F. in Journ. W.A. Nat. Hist. Soc. p. 8 (1904).

The author says "It may ultimately prove to be a viscid form of *A. ephedroides* Benth." This may be so; I do not think so, but until complete material of *A. ephedroides* is available it is best to let *A. Tratmaniana* stand, especially as the four-angled phyllodes appear to be distinct, and there are other differences.

Mr. Fitzgerald describes his *A. Tratmaniana* with "calyx broadly turbinate." The type comes from Cunderdin. I

have it also from Kellerberrin (F. H. Vachell and A. E. Lankester); also Kwelkan, north of Kellerberrin, a shrub of 7–8 feet (Dr. F. Stoward, No. 153).

A. FILIFOLIA Benth.

This species was described in Hooker's Lond. Journ. Bot. I, 369, (1842) in words of which the following is a translation.

161. Glabrous with terete branchlets; phyllodes long, filiform, rigid, terete, very finely striate, shortly and straightly mucronate at the apex; spikes ovoid, dense, solitary, sessile. Phyllodes 4 – 6 in., much thinner than in the following ones (*ephedroides*, *xylocarpa*, *arida*, *oncinophylla*, J.H.M.) and not uncinate at the apex. Spikes sometimes almost globose. Swan River, *Drummond.* Bentham in London Journ. Bot. I, 369 (1842).

It will be observed that the describer had only phyllodes and unexpanded flower-buds.

There is a reference to the species in Pl. Preiss, I, 18, with a statement that Drummond's No. 302 (one of the specimens quoted under *A. ephedroides* in B. Fl. ii, 400) is referable to it, and he adds that it is not found in Preiss's collection.

While Bentham sinks it under his *A. ephedroides* Benth., the specimens that I attribute to *A. filifolia* are certainly not that species. I will supplement the description of *A. filifolia* as I interpret it in the following particulars. [I may say that I have not a specimen of the type, and that the specimens I have seen attributed to that species only agree in having filiform leaves.]

Phyllodia 4 – 6 inches long, terete, or slightly flattened, with fine striate lines, some more nerve-like than others. Sometimes with a slight hoary tomentum. Attachment terete, slightly wrinkled. Flowers in short ovoid spikes, sessile or with very short peduncles, about $\frac{1}{4}$ inch long, 5-merous. Occasionally in pairs. Floral bract capitate,

rugose. Calyx narrow-lobed, free to the base or nearly so, spathulate with rugose apex, thin, smooth. Petals united about half way up, separating at a touch, glabrous. Pistil hoary-tomentose. Pods terete, smooth, with a resinous incrustation. Seeds longitudinally placed, and when ripe suspended from the pods by a filiform funicle, which is attached to a broad arillus.

I have seen it from Coolgardie (L. C. Webster). "A tall shrub," Cowcowing (Max Koch, 1025, and also found mixed with 1338). 132 miles and upwards, Watheroo Rabbit Fence (Max Koch, 1338a). Kurrawang, near Kalgoorlie (Dr. J. B. Cleland). Dr. F. Stoward, Nos. 223 and 224, no localities. Bruce Rock-Merriden district (Dr. F. Stoward, Nos. 8 and 14). Kunonoppin (Dr. F. Stoward, No. 75). The only pods I have seen. These are identical with the pods from the same place (F. E. Victor), described by the late Dr. A. Morrison as *A. aciphylla* Benth. in the "Scottish Botanical Review," April, 1912, p. 99.

There is some danger (with flowering material) of confusion with *A. leptoneura* on a casual glance, but the flower-heads of the latter are uniformly spherical, while those of *A. filifolia* are either ovoid or a little longer. The young phyllodes of *A. leptoneura* are soft, golden pubescent; those of *A. filifolia* are stiff, rugose, resinous.

The pods and seeds display a marked difference. The pods of *A. leptoneura* are flattish; those of *A. filifolia* are terete. The seeds of *A. leptoneura* have a funicle with two folds and a barely expanded arillus; those of *A. filifolia* have a very broad arillus, and the commencement of the filiform funicle is on the opposite (the ventral) side of the seed or base of arillus to that from which the attachment of the funicle springs. In other words, the funicle appears to cross over from one side of the valve to the other.

XVIII. A. Jutsoni n. sp.

Frutex, ramulis angulatis v. fere teretibus. Phyllodiis lineari-tetragonis, rigidis, leniter curvatis mucrone breve pungente, 6·5 – 8 cm. longis, utroque latere striatis, junioribus partibus viscidis, cum costis parallelibus, brevibus pilis tectis. Floribus in spicis brevibus ovoidiis densis, breviter pedunculatis, ca. 7 mm. longis. Calyce turbinato, pilis paucis sparsis disperso. Petalis calycem ca. triplo superantibus, sub lobis cohaerentibus. Legumine non viso.

Apparently an erect shrub, branchlets slightly angular or nearly terete. Phyllodia linear-tetragonal, rigid, slightly curved, with a short pungent point, 6·5 – 8 cm. long, each of the sides uniformly exhibiting a rounded rib, giving the phyllode a grooved appearance, the young growth viscid, but with parallel ridges covered with short white hair, the mature phyllodes covered with a very short tomentum.

Flowers in short ovoid dense spikes, shortly pedunculate, about 7 mm. long. Flowers mostly 5-merous. Calyx turbinate, sprinkled with a few scattered hairs, about a third the length of the corolla. The petals united immediately below the lobes. Pistil small and smooth. Pod not seen.

The type is from Comet Vale, near a railway station 63 miles north of Kalgoorlie (John Thomas Jutson, Nos. 160 and 49 of December, 1916).

The following specimens belong to this species, although their phyllodes are, for the most part, less tetragonal, sometimes becoming almost terete, with striæ.

a. Elder Exploring Expedition, Camp 54, Victoria Desert, 17th September, 1891 (R. Helms, No. 14). "On sand." Latitude 29° 33′ 25″, Longitude 124° 50′, height 1,100 feet.

b. Phyllodes resinous all over. Coolgardie (L. C. Webster, year 1898).

Affinities.

1. With *A. resinomarginea* W. V. F. It seems that this species is perhaps closest to *A. Jutsoni*, subject to the discovery of fruits. The phyllodes of *A. resinomarginea* are somewhat flatter and have "the angles margined with a crenulated resinous line;" the spikes of flowers of *A. resinomarginea* are more interrupted, but the individual flowers of the two species resemble each other very closely.

2. With *A. microneura* Meissn. This species has a general resemblance to *A. Jutsoni*, but in *A. microneura* the phyllodia are flattened, and the spikes sessile; the flowers are different, *e.g.*, in *A. microneura* the calyx is more divided and more hairy, while the petals are divided low down, the corolla not being gamopetalous as in *A. Jutsoni.*

3. With *A. Tratmaniana* W. V. F. The leaves of this species are more filiform, more rigid and more numerous, but the individual phyllodes are quadrangular, although the sculpture is different, there being an absence of the central rib on each side. The spikes of *A. Tratmaniana* are sessile, the calyx more deeply cleft, and the petals separate.

Julifloræ (Falcatæ).

XIX. A. ACUMINATA Benth.

A. OLDFIELDII F.v.M. A. SIGNATA F.v.M.

A. LASIOCALYX C. Andrews.

Under his own *A. acuminata*, Bentham in B. Fl. ii, 404, quotes Drummond's 3rd Coll. No. 99. A large specimen received from the British Museum is neither in flower nor fruit, but there is no doubt it is *A. lasiocalyx* C. Andrews. Drummond's specimen, quoted as No. 9, also without flower and fruit, is the same species. This reputed 9 is probably a reversed 6, and is Drummond's 5th Coll. No. 6, as quoted in B. Fl. ii, 404.

A. acuminata has smaller phyllodes, with the margins often ciliate. Fruits of *A. acuminata* are very rare in collections; they were described by Bentham, and also by Mr. W. V. Fitzgerald in Journ. W. A. Nat. Hist. Soc., p. 52 (May, 1904). I have received fruits from Kununoppin, January, 1917 (Dr. F. Stoward) and they present a very considerable similarity to those of *A. lasiocalyx*, additional evidence of the affinity of the two species. The *A. acuminata* pods I have are pale brown, glabrous, with valves more woody, more embossed by the seeds, and the rims more marked.

A. Oldfieldii F.v.M., Fragm. iv, 7.

Bentham (B. Fl., ii, 404) considers this to be a synonym of *A. acuminata.*

I have been favoured by Professor Ewart of the Melbourne Herbarium with a sight of the type. The material consists of a twig with a few mature phyllodes with some small young shoots with golden pubescence, some loose phyllodes, a fragment of a spike of flowers (loose), and a detached pod with ripe seeds. Such material is obviously unsatisfactory. At the same time, it is very desirable that descriptions of species should be investigated, and I therefore submit the following notes.

I do not disagree with Bentham's opinion that *A. Oldfieldii* is synonymous with *A. acuminata* Benth.

Phyllodes $2\frac{1}{2}-4\frac{1}{2}$ inches long, $1\frac{1}{2}-2\frac{1}{2}$ lines broad, as seen by me. The old phyllodes are quite glabrous, but the young growth is golden pubescent as in *A. acuminata.* Branchlets angular.

Flowers 4-merous. Calyx yellow pubescent, denticulate. Corolla short-glabrous. Pods $2-4$ inches long, $1-1\frac{1}{2}$ lines broad. Seeds elliptical and longitudinally arranged. They are not the pods of *A. acuminata.*

The type of *A. Oldfieldii* came from the Murchison River "in rather dry places," and was collected by Oldfield.

A. SIGNATA F.v.M., Fragm. iv, 7.

In B. Fl. ii, 404, Bentham says "Foliage of *A. acuminata*, but the fruit different."

There has been a good deal of confusion in Australia in regard to *A. signata*, and I am inclined to think that Bentham had wrong, or poor, material before him. (The type consists of phyllodes and pods only). First of all let me re-describe the plant from ample and fresh material.

Small tree, about 15 feet high, with branchlets sub-angular towards their extremities, round when older, the young branchlets and pods slightly glaucous.

Phyllodia linear-lanceolate, slightly falcate 10–14 cm. (say 4–5½ inches) long, and 5 mm. broad, tapering slightly into a dark-coloured curved, moderately sharp apex, moderately thick, with numerous fine parallel nerves, the central one more prominent. With thin nerve-like margins, reddish in colour, like the branchlets.

Flowers in short pedunculate spikes, the spikes 1–1·5 cm. long, and the peduncles about 1 cm. The spikes sometimes so short as to be almost ovoid; 5-merous.

Calyx matted with white hairs, sepals free nearly to the base, not quite half as long as the corolla. Petals glabrous, free, very thin, separating about half way down, the tips somewhat thickened. Pistil silky pubescent. Pods shortly stipitate, linear, slightly falcate, about 11 cm. long by 5 mm. broad, glaucous; the rather small, ovoid, flattish seeds longitudinally arranged, and pendulous when ripe; areole oblong, the funicle very narrow, soon passing with one or two folds, into a crumpled, broad ribbon-like mass terminating in a cup-shaped arillus.

The type of *A. signata* comes from the Murchison River, *Oldfield.*

I have it also from Minginew (E. W. Hursthouse through W. V. Fitzgerald, as *A. acuminata*).

Dr. F. Stoward has sent it from Bruce Rock to Merriden, September, 1916, in flower; December, 1916, in flower and fruit, and also on poorest sandy land, about 10 miles south of Merriden and Totadgin district. December, 1916, in fruit. The above description has been drawn up from Dr. Stoward's specimens checked with the scanty specimen of the type, which Prof. Ewart has had the kindness to lend me. The flowers are described for the first time.

Affinities.

1. With *A. acuminata* Benth.

Bentham (B. Fl., ii, 404), speaking of *A. signata*, says "Foliage of *A. acuminata*, but the fruit different."

A. acuminata is the "Jam" or "Raspberry Jam" tree that every West Australian knows. Its young foliage has a golden pubescence, while the margins of the phyllodes are often ciliate.

A. signata is never more than a shrub or very small tree. It is usually less floriferous, its phyllodes are usually broader and have more of the lustre of parchment, with red branchlets and red phyllode-margins. Its branchlets are more angular. Its venation is finer, the pods have a more waxy or hoary lustre.

2. With *A. lasiocalyx* C. Andrews.

The phyllodes differ in dimensions and in venation, but the flowers are quite different, the calyx of *A. lasiocalyx* being truncate and the pistil smooth, as compared with a pubescent pistil in *A. signata*.

The pods of *A. signata* are somewhat smaller than those of *A. lasiocalyx*, and the seeds are more orbicular and

flatter, the areole more distinct and from oblong to elliptical in shape. The funicle is longer and the seeds are more persistent; remaining hanging from the pod.

E. Pritzel's No. 559, recorded as *A. signata* in Engler's Bot. Jahrb. xxxv, 308, is *A. lasiocalyx.*

3. With *A. stereophylla* Meissn. There is a general similarity of appearance between *A. stereophylla* and *A. signata* when in flower, but the phyllodes of the former are much more rigid and thick, with hardly visible nerves, and there is an absence of the reddish nerve-like margins seen in *A. signata.* As regards the structure of the flower, the calyx and pistil of *A. signata* are far more hairy than that of *A. stereophylla*, and the shapes and relative sizes of the calyces are different.

4. With *A. Beauverdiana* Ewart and Sharman. There is considerable superficial resemblance with the broader phylloded forms of this species. The phyllodes of both species have numerous parallel veins, but those of *A. signata* have a more prominent central one. The spikes of *A. Beauverdiana* are nearly sessile and more ovoid, while the structure of the flowers is different, the calyx of *A. Beauverdiana* being truncate.

A. LASIOCALYX C. Andrews, Journ. W. A. Nat. Hist. Soc., 41 (May, 1904).

Contrasted by the describer with *A. doratoxylon* A. Cunn. The pod was not seen, and the type came from sand plains near the Gairdner and Hammersley Rivers (at Jerramungup).

Pods have been received from Kununoppin, January, 1917 (Dr. F. Stoward). They differ from those of *A. signata* in being slightly larger, with thicker, more oblong and larger seeds marked by a spherical areole. The funicle is shorter and the seeds are not pendulous from the pod, as in *A. signata.*

The type locality is the most northerly one known to me, and we have it from "In fruticetis Moore River" (E. Pritzel, No. 559, as *A. signata*).

Following is a translation of a brief account of this plant, which I find to be *A. lasiocalyx*.

"*A. signata* F.v.M. Phyllodes up to 30 cm. long, falcate, up to 4 mm. broad. Habitat in Avon district in 'Victoria Plains,' in sandy places. Flowering in August (D. 3970; E. Pritzel, No. 559). South towards the Eyre district near Peniup. (D. 4739)." (Diels and Pritzel in Engler's Bot. Jahrb. xxxv, 308, 1905).

We have it on the Eastern Railway and its branches from Kunonoppin (Dr. F. Stoward, No. 61); Kellerberrin (Miss Leake, F. H. Vachell); Bruce Rock to Merredin (Dr. F. Stoward, No. 24); Coolgardie (L. C. Webster).

Going further south, Mr. Muir collected it from "100 miles north of Stirling Range," and I have received it from Prof. Ewart from the Tulbrunup Swamp, which is of course adjacent to the Stirling Range (collector not given).

Then we have *A. acuminata* Benth. var. *glaucescens* E. Pritzel in Engler's Bot. Jahrb., xxxv, 308. The following is a translation.

"Straight phyllodes with the pods thickly marginate, glaucescent. In the Coolgardie district near Karalee, form scrub with Eucalypts (D. 5579). Fruiting in November."

In the absence of specimens I suggest that this variety may be *A. lasiocalyx*.

XX. A. BEAUVERDIANA Ewart and Sharman, in Proc. Roy. Soc. Vict. XXVII, (2nd Series) 230. As Plurinerves (Microneura), aff. *A. coriacea* DC.

Type from Cowcowing. I have since obtained it from the Bruce Rock-Merriden district (Dr. F. Stoward). It varies a good deal in the width of the phyllodes, and not

only are the flowers in "globular heads very slightly cylindrical," but some are so distinctly cylindrical as to justify removal of the species to the Juliflorae. I think its position is next to *A. signata.*

The pods are hitherto unknown, and may be described as follows:—

Stipitate, linear-moniliform, the seeds longitudinally arranged, the valves thin, with a marginal thickening, 6 – 7 cm. long, with a width of 3 mm. where distended by the seeds, and half this width between the seeds; seeds shining, elongated, suspended by a delicate ribbon-like funicle which terminates in a slightly expanded arillus. (Poor sandy land, ten miles south of Merredin, March, 1917. Dr. F. Stoward, No. 82).

XXI. A. Stowardi n. sp.

Frutex glaber. Phyllodiis lato-linearibus, rectis vel paullo falcatis in acumen obtusum leniter curvatum terminantibus, 4 – 6 cm. longis, 3 mm. latis, rigidis, crassis, tenuiter striatis, nervis numerosis tenuibus parallelibus, nervo medio prominentiore. Pedunculis 5 mm. longis, solitariis, capitulo ovoideo v. spica sub-cylindrica v. sub-laxa, 1·5 cm. longo. Floribus 5-meris. Calyce sinuato-dentato corollam minus dimidio æquante, glabro. Petalis dimidio longitudinis cohaerentibus, glabris. Pistillo pruinoso. Leguminibus tenuibus sub-obliquis, 4 v. 5 cm. longis, 1 cm. latis, valvarum marginibus angustis incrassatis, valvis leniter nervosis. Seminibus ovatis, obliquis v. fere transversis, funiculo duplo plicatis in arillum leniter incrassatum terminante.

A glabrous shrub, the young tips slightly resinous, the young branchlets angular, but soon becoming terete.

Phyllodia broad-linear, straight or slightly falcate, terminating in a slightly curved blunt point, gland near base, sometimes narrowed at the base into a distinct yellowish curved petiole, mostly 4 – 6 cm. (say $1\frac{1}{2}$ – $2\frac{1}{2}$ inches) long,

3 mm. broad, rigid, thickish, finely striate with numerous fine parallel nerves, scarcely visible without a lens, the central one sometimes rather more prominent than the rest, and so visible to the naked eye.

Peduncles somewhat angular, resinous, erect, short, usually about 5 mm. long and single, straight, bearing an ovoid head or a subcylindrical or a somewhat loose spike of 1·5 cm. (say $\frac{1}{2}$ inch) long.

Flowers 5-merous. Calyx sinuate-toothed, not half as long as the corolla, glabrous. Petals united about half-way down, glabrous. Pistil hoary.

Pods thin, somewhat oblique, somewhat narrowed at the base, 4 or 5 cm. long, and 1 cm. wide, the sutures edged with a narrow thickened margin, and the valves slightly veined. Seeds ovate oblique or almost transverse, prominently embossing the valves, the funicle in two folds, terminating in a not very much thickened arillus.

Comet Vale, 63 miles north of Kalgoorlie. (John Thomas Jutson, No. 281, in flower; No. 175, in fruit).

This may be a puzzling species, because it varies from inflorescence in heads to inflorescence in spikes, but the spikes are so marked in some of the specimens that it had better be put in the Julifloræ.

The following specimens illustrate the above variation:—

(*a*) Ovoid heads scarcely more than globular, Goongarrie, 55 miles north of Kalgoorlie (J.H.M.); Tampa, 120 miles north of Kalgoorlie (J. T. Jutson); Comet Vale (J. T. Jutson, No. 253).

(*b*) Short oblong spikes, hardly twice as long as broad. Comet Vale (J. T. Jutson, Nos. 271, 253).

(*c*) Decidedly spicate (Comet Vale, J. T. Jutson, Nos. 281, 282). So far, therefore, the species has been traced between sixty and seventy miles north of Goongarrie.

It is named in honour of Dr. Frederick Stoward, Government Botanist and Vegetable Pathologist, Department of Agriculture of Western Australia, who has vigorously helped me in the elucidation of this beautiful and interesting genus, so well developed in his State.

A. Beauverdiana Ewart and Sharman affords another illustration of a species having flowers both in globular heads and cylindrical spikes, and this has been noted in regard to a few others. It is but another illustration of the fact that all morphological characters used in classification vary, and must be interpreted philosophically.

Affinities.

1. With *A. Beauverdiana* Ewart and Sharman.

As already pointed out, this is another species which hovers between the groups with globular and cylindrical heads. The two species appear to be closest allied.

But the phyllodes of *A. Beauverdiana* are more erect; they resemble each other in venation. The peduncles are very often recurved in *A. Beauverdiana*, straight in *A. Stowardi.* As regards the flowers, the calyx is proportionately much longer in comparison with the corolla in *A. Beauverdiana*, while the two species are sharply separated by the pods, those of *A. Beauverdiana* being narrow and moniliform.

2. With *A. duriuscula* W.V.F.

There is a good deal of external similarity between these two species, but if we examine them carefully, we find that flowers in spikes are unknown in *A. duriuscula*, while the calyx is more than half as long as the corolla in that species, and not half as long in *A. Stowardi.* The phyllodes of *A. duriuscula* are shorter and more resinous, though in neither species is it abundant; those of *A. duriuscula* are less smooth to the touch, as the venation is coarser, *i.e.*, the

veins are thicker and more prominent, yet in both it would be termed fine. The pod of *A. duriuscula* is unknown.

XXII. A. QUADRIMARGINEA F.v.M., Fragm. x, 31.

Was described without flowers. The following description of them is by Mr. Fitzgerald.

"A bushy shrub, 5–7 feet high; peduncles often two together, 4 lines long; flowers in ovoid or semi-spicate heads of 20, mostly 5-merous; bracts ciliate; calyx shortly toothed, half the length of the corolla, hirsute; corolla divided half-way down, the petals with prominent midribs. In sandy soil. Referable to *A. heteroneura* Benth." (MSS.)

The type locality is Ularing, in the Menzies district, W. A. (Young); Mr. Fitzgerald found it at Gwalia, W. A.

The following specimens are referable to this little known species.

1. Coolgardie. In flower, June, 1899 (R. Helms).

2. On granite plateau, three miles north-east from Cue. In flower, June, 1902. (W. D. Campbell).

3. Tampa, 120 miles north of Kalgoorlie. In flower. July 1915 (J. T. Jutson, No. 29).

4. Bushy shrub, 5–7 feet high. In fruit. November, 1903 (W. V. Fitzgerald). In two forms, one with phyllodes slightly narrower than the type, and the other very much narrower than the type (neither in flower or fruit), almost linear.

I have not seen any flowering specimen collected or seen by Mr. Fitzgerald, and do not understand his words "Referable to *A. heteroneura* Benth." (Plurinerves: Nervosæ). At the same time his description of the flowers is accurate, although it will bear amplifying.

A. quadrimarginea belongs to the Juliferæ (Falcatæ) and some of the heads are short and nearly ovoid. Under the

circumstances it may be desirable to partly re-describe the species, taking Helms' Coolgardie specimen for the purpose.

Phyllodes with one central nerve, finely striate, gland near base, edges resinous and granular. Flowers 5-merous, in short spikes, the peduncle clothed with hair; floral bracts capitate. Calyx very narrow, spathulate, about half as long as the corolla; with long irregular, transparent processes. Petals glabrous, united about half way down. Pistil very resinous, probably smooth.

A. heteroneura is quite distinct from *A. quadrimarginea.* The phyllodes of the former are almost trigonous, the central nerve is much raised on both sides of the phyllode, and there are three or four fine distinct nerves on each side. Gland near base. The phyllodes of *A. quadrimarginea* are flat with a faint central nerve. The nerves on each side are indistinct. The plant appears to be quite glabrous, and the gland is some distance from the base. The pods of *A. heteroneura* are very narrow, those of *A. quadrimarginea* broad, angled and almost winged.

Mueller (in absence of flowers) was naturally uncertain as to the position of *A. quadrimarginea*, and suggested affinities to *A. quadrisulcata* and *A. lineolata.* Its position appears to be near *A. tarculensis* J. M. Black. It differs from that species in the longer and narrower phyllodes, in the single spikes, and in the glabrous pistil (that of *A. tarculensis* being pubescent).

Bipinnatæ (Pulchellæ).

XXIII. A. Drewiana W. V. Fitzgerald, n. sp.

An erect unarmed shrub, invested with white spreading hairs; the branchlets slightly angular; leaves bipinnate, the pinnæ in two pairs, the lower at the base of the common petiole, the latter terminating in recurved acute points;

leaflets 3 – 4 pairs, lanceolate to oblong, obtuse, scabrous-hirsute above, pale and glabrous beneath, margins recurved, midrib evident; peduncles solitary, hispid, each bearing a globular head of about 30 mostly 4-merous flowers; bracts setaceous; sepals linear-spathulate, scarcely half as long as the corolla, free or almost so, ciliate; petals almost free, ovate, obtuse, glabrous, with evident midribs.

Type from Cannington (W.V.F.). Height 3 – 4 feet. Pinnæ to $\frac{1}{2}$ inch long, the common petiole 7 – 9 lines long. Leaflets 2 – 3 lines long. On a heathy flat. Named after the Honourable J. M. Drew, a former Colonial Secretary, Western Australia. Affinity to *A. nigricans* R. Br.

AZURITE CRYSTALS FROM MINERAL HILL, NEAR CONDOBOLIN, NEW SOUTH WALES.

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(Contribution from the Australian Museum.)

With Plates V, VI.

[*Read before the Royal Society of N. S. Wales, October 3, 1917.*]

AMONG recent additions to the mineral collection of the Australian Museum are three hand specimens of beautifully crystallised azurite from the Iodide Mine, Mineral Hill. A number of the crystals have been measured on the goniometer and the results are embodied in the present paper; at the same time the elements of azurite are discussed in the light of the angular measurements obtained and new constants have been calculated from these angles.

Occurrence and Associated Minerals.

The Mineral Hill Silver Field has been described by Mr. E. F. Pittman.[1] It is situated in Parish Talingaboolba, Co. Kennedy, about 42 miles north of Condobolin. The ore-deposit occurs in gritty sandstones and slates, probably of Devonian age. In the ore-body these rocks have been metamorphosed into very hard, dense, siliceous rocks such as quartzite and jasper, and the ore-body itself consists essentially of friable, gossany material with interspersed masses of quartzite, and containing such minerals as cerussite, azurite, cuprite, and cerargyrite. The workings have not reached the unoxidised zone (the mine is now idle), but Mr. Pittman concludes that these minerals will be found to give place at a depth to argentiferous galena, associated in places with chalcopyrite.

[1] Pittman, Ann. Rept. Dept. Mines N.S.W., 1912 (1913), pp. 170–172.

The three hand specimens seem to be nodular in origin, and the best crystals are found inside hollow nodules. In two of the specimens, which may be called A and B, the azurite is seated on a dark, gossany mixture, consisting mainly of limonite with small quantities of cerussite and malachite. In A the malachite is apparently more recent than the azurite which it partly pseudomorphs; malachite also occurs on this specimen as small spherules. On B malachite is found as little globular masses, umber coloured externally and dark green inside; it was at first thought that these might be atacamite, but they gave no reaction for chlorine. Specimen C is larger than the others and the crystals of azurite are quite fresh and show no signs of alteration to malachite, which appears as bright green, fibrous tufts amongst the cerussite. A typical vugh in this specimen is lined with a crystalline crust of cerussite on which the azurite rests; the walls of the vugh are composed of a hard, siliceous shell, jasperoid in part, and traversed by veinlets of azurite and cerussite in a direction at right angles to the inside surface of the vugh. The nodules on specimen C are coated externally by a yellowish powder, which contains lead in large amount; this coating is probably identical with a substance which sometimes forms fairly large masses at Mineral Hill and which was found by Mr. J. C. H. Mingaye, Analyst to the Department of Mines, to contain 165 oz. silver, 54 per cent. lead, 5·4 per cent. antimony, and a trace of gold. It seems to be an impure mixture of massicot and bindheimite. Cuprite and cerargyrite were not observed in immediate association with the azurite, but crystallised specimens of these minerals from the Iodide Mine are in the Museum Collection; these and the cerussite, which is mostly in aggregated crystals twinned on m (110), will be described in another paper now in course of preparation.

The Azurite Crystals.

The azurite is mainly attached to the matrix obliquely by one end of the symmetry axis; where the crystals are not too crowded they are finely formed, and among those detached for measurement some are doubly terminated. They vary in length from about ·25 cm. to 1·75 cm., and average perhaps ·5 cm.

Eighteen crystals were measured on a two-circle goniometer, and several more were carefully examined for additional features of interest. As some of the best crystals were measured more than once and in different settings, a large number of angular measurements were made and the average values for the best faces are believed to have a high degree of accuracy. A total of twenty-one forms, of which one is new, was obtained; doubtful and vicinal forms are omitted from the lists but are dealt with below. The forms are as follows, that marked by an asterisk being new: c (001), b (010), a (100), m (110), w (120), l (023), f (011), p (021), ϕ (201), σ (101), θ ($\bar{1}$01), η ($\bar{3}$02), v ($\bar{2}$01), h (221), s(111), P(223), k ($\bar{2}$21), γ (121), R ($\bar{2}$41), X*($\bar{4}$81), λ ($\bar{2}$·18·3).

Combinations.—The following table gives the combinations observed on the eighteen crystals:

FORMS.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
c (001)	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
b (010)	...	...	...	...	...	...	...	b	...	...	...	...	...	b	...	...	...	...
a (100)	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
m (110)	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
w (120)	w	w	w	w	w	w	w	w	w	w	w	w	w	w	w	w	w	w
l (023)	l	l	l	l	l	l	l	l	l	l	l	l	l	l	l	l	l	l
f (011)	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f
p (021)	p	p	p	p	p	p	p	...	p	p	p	p	p	p	p	p	p	p
ϕ (201)	ϕ	...	ϕ	ϕ	ϕ	ϕ	...	ϕ	ϕ	ϕ	ϕ	ϕ	...	ϕ	ϕ	ϕ	ϕ	ϕ
σ (101)	σ	σ	σ	σ	σ	σ	...	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ	σ
θ ($\bar{1}$01)	θ	θ	θ	θ	θ	θ	θ	θ	θ	θ	θ	θ	θ	θ	θ	θ	θ	θ
η ($\bar{3}$02)	η	η	η	η	η	η	η	η	η	η	η	η	η	η	η	η	η	η

FORMS.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
v ($\bar{2}01$)	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
h (221)	h	h	h	h	h	h	h	h	h	h	h	h	h	...	h	h	h	h
s (111)	...	...	s	...	s	...	...	...	s	...	...	...	...	...	s	s	s	...
P (223)	...	...	P	...	P	...	...	...	P	...	P	...	...	...	P	...	P	...
k ($\bar{2}21$)	k	k	k	k	k	k	k	k	k	k	k	k	k	k	k	k	k	k
γ (121)	...	...	...	γ	γ	...	...	...	...	...	...	...	...	...	...	...	γ	γ
R ($\bar{2}41$)	R	R	R	R	R	R	R	R	R	R	R	R	R	...	R	R	R	...
X ($\bar{4}81$)	X	X	...	X	X	X	...	X	...	...	X	...	...	...	...	...	...	...
λ ($\bar{2}\cdot18\cdot3$)	λ	λ	...	λ	λ	λ	...	...	...	...	...	...	...	...	...	...	...	...

In the above list Nos. 1 and 2 are from specimen A, Nos. 3 to 6 from B, Nos. 7 to 18 from C, and it will be observed that λ does not occur on the crystals of C, also that the new form X is commoner on specimen A and B; otherwise the combinations are very similar for all the crystals.

New form X ($\bar{4}81$).—This was found on seven crystals and its indices were determined from the following measurements; in most cases the reducing objective was used as the faces are small.

Crystal.	Signal.	ϕ	ρ	Average.	Calculated.
1	good	$\overline{30}°\ 21'$	$83°\ 10'$		
2	fair	$\overline{30}\ 12$	$82\ 57$	ϕ $\overline{30}°\ 6'$	$\overline{30}°\ 1'$
4	good	$\overline{30}\ 15$	$83\ 5$	ρ $83\ 2$	$83\ 2$
5	fair	$\overline{30}\ 0$	$83\ 5$		
		$\overline{30}\ 3$	$82\ 49$		
8	fair	$\overline{29}\ 43$	$83\ 4$		

The form occurs as a minute line face or a spot between w (120) and R ($\bar{2}41$); although it is small, the signals are distinct, and the form may be considered as established beyond doubt.

Doubtful forms.—In all the crystals there is a much striated area between c (001) and θ ($\bar{1}01$) which gives a succession of overlapping signals. No forms can be definitely established here, but μ ($\bar{1}05$) and D ($\bar{1}04$) are

probably present, and possibly F ($\bar{2}07$), A ($\bar{1}03$), and B ($\bar{5}04$). The following are the values obtained for ρ from the stronger reflections.

Form.	Crystal.	ρ	Average.	Calculated.
μ ($\bar{1}05$)	2	8° 14′	8° 33′	9° 21′
	1	8 6		
	3	8 14		
	18	9 39		
D ($\bar{1}04$)	3	12 32	12 25	12 12
	12	13 24		
	15	13 20		
	17	11 40		
	17	11 12		
F ($\bar{2}07$)	8	14 32	14 37	14 12
	16	14 43		
A ($\bar{1}03$)	8	16 44	16 57	16 50
	12	17 11		
B ($\bar{5}04$)	3	50 52	50 52	51 21

Habit.—There are two habits of which Habit I is peculiar to the crystals of specimens A and B. This habit [Plate V] may be described as elongated parallel to the symmetry axis and tabular on the plane of the b and c axes. Only two pinacoids are present; of these c (001) usually has an oblong face, never very large but fairly smooth and giving good reflections; a (100) is a well developed form, oblong or nearly square in shape and striated horizontally. The unit prism m (110) is large and brilliant; it is sometimes slightly striated vertically, but generally gives an excellent reflection of the signal. The prism w (120), though always present, is never large, being represented by a long, narrow face; w (120) and w' ($\bar{1}20$) generally meet in a long vertical edge [Plate V, figs. 2, 3]. The orthodome zone is well developed, but the negative orthodomes, particularly θ ($\bar{1}01$) and v ($\bar{2}01$), are strongly striated parallel to the zone edges and give multiple reflections; there is the usual indefinite striated area between c and θ. Of the clinodomes p (021) is usually small and almost triangular, f (011) is

well developed but not so large as *l* (023), which is one of the dominant forms; all three reflect well and give good signals, although *f*, and particularly *l*, are sometimes striated parallel to their intersections. None of the pyramids are large; *h* (221), *k* ($\bar{2}21$), and *R* ($\bar{2}41$) are the best developed and are invariably present. The rare pyramid λ ($\bar{2}\cdot18\cdot3$), which is present on all but one of the crystals with this habit, and always accompanied by the new form *X* ($\bar{4}81$), is occasionally a fairly large polygonal face [Plate V, fig. 4), separating *w* and *w′*, but usually it is quite small and elongated. The following angular measurements were obtained for λ:

Crystal.	Signal.	ϕ	ρ
2	good	$\bar{7}°\ 6'$	79° 29′
4	good	$\bar{7}\ 7$	79 39
5	good	$\bar{6}\ 53$	79 19
5	fair	$\bar{7}\ 3$	79 27
5	fair	$\bar{6}\ 55$	79 25
5	fair	$\bar{6}\ 42$	79 25
5	good	$\bar{6}\ 58$	79 23
6	good	$\bar{6}\ 58$	79 32
6	good	$\bar{6}\ 53$	79 16

	Average.	Calculated.
ϕ	$\bar{6}°\ 57'$	$\bar{6}°\ 57'$
ρ	79 26	79 25

Habit II [Plate VI] is characteristic of the crystals on specimen C. The crystals are, as before, elongated parallel to the symmetry axis, but they have in this case a tendency towards tabularity on the plane of the *a* and *b* axes, so that the edge at the end of the *b* axis now runs horizontally and is formed by the meeting of the faces *p* (021) and *p′* ($02\bar{1}$). [Plate VI, figs. 2, 4]. The three pinacoids are here represented, although *b* (010) was observed on only two of the crystals, and then as a mere line face. The base is always present, usually as a long narrow face. The orthopinacoid *a* (100) is large and slightly striated parallel to its intersections with *m* (110) and the orthodomes; there is some oscillation between *a* and *m*. The prism *m* is much less

developed than in the crystals of Habit I, and w (120) is here usually a small triangular face. The orthodome v ($\bar{2}01$) is, as before, strongly striated parallel to its intersection with a (100). The "no man's land" between c (001) and θ ($\bar{1}01$) is in some cases of considerable breadth and has a strong influence on the general shape of the crystal [Plate VI, figs. 1, 2]. It is gently curved, finely striated, and gives a regular succession of signal reflections in the telescope; readings were obtained from dominant reflections which indicate the presence of μ ($\bar{1}05$), D ($\bar{1}04$), F ($\bar{2}07$) and A ($\bar{1}03$); of these D is the most probable and it is included in fig. 4. The three clinodomes l (023), f (011), and p (021), are well developed and smooth, particularly l and f, though l is sometimes slightly striated parallel to the zone edge. Of the pyramids, h (221), k ($\bar{2}21$), and R ($\bar{2}41$) are the most prominent as before. The new form X ($\bar{4}81$) was observed on two crystals, s (111) and P (223) each on four and usually simultaneously; γ (121) was found twice as a narrow face between m (110) and f (011). The pyramid λ ($\bar{2}\cdot18\cdot3$) is never present on the crystals of this habit.

Elements.

The elements of azurite are in a curious position. Those adopted in standard works, such as Dana's 'System of Mineralogy,' Groth's 'Chemische Krystallographie,' Goldschmidt's 'Index der Krystallformen' and 'Winkeltabellen,' were determined by Schrauf from measurements on the azurite from the well-known locality Chessy in France, although the later authors have generally taken half the length of the vertical axis chosen by Schrauf. Schrauf's classic paper[1] was published in 1871 and most crystallographers who have since measured the angles of azurite from other localities have found marked discrepancies between the values obtained and those calculated from

[1] Schrauf, Sitz. d. k. Akad. Wiss. Wien, LXIV, 1871, abth. 1, pp. 123 – 136.

Schrauf's elements. Farrington was, I believe, the first to remark on this variation; in his study of the azurite of Arizona,[1] he points out, for example, that the measured angle $m \wedge m$ closely approximates to 81° 8′ instead of 80° 42′ as calculated by Schrauf. Farrington was not able to say "whether this variation is to be regarded as a fundamental difference in the prismatic angle of the crystals from the separate localities, or, on the other hand, as so small as to be within the limits of error of observation." Evidence has now accumulated which shows that there *is* a fundamental difference, and that Schrauf's elements, though correct no doubt for the azurite of Chessy, are not the best for crystals from other localities such as Arizona, Broken Hill, N. S. Wales,[2] Muldiva and Girofla Mines, Queensland,[3] Tsumeb, German S.W. Africa,[4] and Calabonna, Sardinia.[5] In all these cases the variation from Schrauf's angles is considerable and in the same direction, which would lead to the conclusion that the azurite of the type locality Chessy is abnormal.

A large number of reliable angles were obtained from measurement of the crystals described in this paper, and by carefully sifting them and rejecting all except those derived from single and distinct reflections, the figures tabulated below resulted:—

Form.	ϕ Average.	ϕ Limits.	ρ Average.	ρ Limits.	Obs
	° ′ ″	° ′ ° ′	° ′ ″	° ′ ° ′	
c (001)	90 0	...	2 24 42	2 22 – 2 27	20
m (110)	49 24½	49 17 – 49 29	90 0	89 57 – 90 3	56
w (120)	30 18	30 14 – 30 22	,,	89 56 – 90 2	16
p (021)	1 23	1 20 – 1 27	60 33 21	60 30 – 60 37	14
f (011)	2 44½	2 42 – 2 49	41 34	41 28 – 41 39	17
l (023)	4 4⅓	4 0 – 4 7	30 38	30 33 – 30 42	10
R ($\bar{2}41$)	$\overline{29}$ 47	$\overline{29}$ 44 – $\overline{29}$ 49	76 14	76 13 – 76 20	17
k ($\bar{2}21$)	$\overline{48}$ 50	$\overline{48}$ 47 – $\overline{48}$ 53	69 37	69 34 – 69 39	14
s (111)	50 35	50 34 – 50 36	54 21½	54 19 – 54 26	4
P (223)	51 4 24	51 1 – 51 8	43 16 36	43 13 – 43 20	5

[1] Farrington, Amer. Journ. Sci., XLI, 1891, pp. 300 – 307.

[2] Steiner, Ann. Mus. Nat. Hung. IV, 1906, pp. 293 – 298; Cohen, Journ. Roy. Soc. N.S. Wales, XLIV, 1910, pp. 577 – 583.

[3] Anderson, Rec. Austr. Mus., VII, 1909, pp. 278 – 279.

[4] Toborffy, Zeits. Kryst. LII, 1913, pp. 225 – 235.

[5] Manasse, Atti d. Soc. Tosc. Sc. Nat., XXIX, 1913, pp. 196 – 209.

From the averages thus obtained we derive the following constants:

Form.	a	c	β	Obs.
c (001)	...	...	87° 35′ 18″	20
p (021)	...	·88550	87 33 4	14
f (011)	...	·88578	87 34 16	17
l (023)	...	·88603	87 35 39	10
m (110)	·85762	...	...	56
w (120)	·85642	...	...	16
k ($\bar{2}$21)	·85727	·88578	...	14
s (111)	·85629	·88553	...	4
P (223)	·85799	·88743	...	5
R ($\bar{2}$41)	·85653	·88559	...	17

By weighting these values according to the number of observations we obtain the elements:—

$$a : b : c = \cdot 85721 : 1 : \cdot 88581,\ \beta = 87^\circ\ 34\tfrac{1}{2}'.$$

Below are tabulated, for comparison, the elements obtained by different authors:—

Author.	Locality.	a	c	β
Schrauf	Chessy ...	·85012	·88054	87° 36′ ″
Lacroix[1]	Chessy ...	·8469	·8789	87 39
Gonnard[2]	Chessy ...	·8477	·8792	...
Farrington	Arizona ...	·85676	·88603	87 36 36
Cohen	Broken Hill	·85608	·88585	87 38
Manasse	Calabonna ...	·85755	·88803	87 41
Anderson	Mineral Hill	·85721	·88581	87 34½

From this table it is apparent that the axial ratios for the azurite of Arizona, Broken Hill, Calabonna and Mineral Hill are in close agreement and differ considerably from those of the Chessy azurite in which the values for both a and c are smaller. The difference may be emphasized as follows:—

	Chessy. Highest Values.	Difference.	Other localities Lowest Values.	Difference.	Other localities Highest Values.
a	·85012	·00596	·85608	·00147	·85755
c	·88054	·00527	·88581	·00222	·88803

[1] Lacroix, Min. de la France et de ses Colonies, III, 1901, p. 751.
[2] Gonnard, Bull. Soc. fr. Min., XXXIII, 1910, p. 248.

The polar elements for the Mineral Hill azurite were calculated from the above elements, and also directly from the measured angles. The results, which are in accordance, are as follows, Goldschmidt's values as given in his 'Index' and 'Winkeltabellen' being added for comparison.

	p_o	q_o	e_o
Anderson	1·03337	·88502	·0423
Goldschmidt	1·0357	·8797	·0419

Forms and Angles.

The forms and measured and calculated co-ordinate angles for the azurite of Mineral Hill are tabulated below, doubtful forms and fractions of a minute being omitted; the new form is indicated by an asterisk.

Form.	Symbol.	Measured.		Calculated.		Obs.
		ϕ	ρ	ϕ	ρ	
c	001	90° 0′	2° 25′	90° 0′	2° 25′	20
b	010	0 0	90 1	0 0	90 0	3
a	100	90 0	90 0	90 0	,,	25
m	110	49 25	,,	49 25	,,	56
w	120	30 18	,,	30 17	,,	16
l	023	4 4	30 38	4 6	30 38	10
f	011	2 44	41 34	2 44	41 34	17
p	021	1 23	60 33	1 22	60 34	14
ϕ	201	90 0	64 40	90 0	64 39	6
σ	101	,,	47 8	,,	47 7	10
θ	$\bar{1}01$	$\overline{90}$ 0	44 49	$\overline{90}$ 0	44 46	9
η	$\bar{3}02$	,,	56 28	,,	56 28	11
v	$\bar{2}01$	,,	63 44	,,	63 44	27
h	221	50 1	70 2	50 0	70 3	11
s	111	50 35	54 21	50 33	54 21	4
P	223	51 4	43 17	51 6	43 14	5
k	$\bar{2}21$	$\overline{48}$ 50	69 37	$\overline{48}$ 50	69 37	14
γ	121	31 14	64 14	31 17	64 15	6
R	$\bar{2}41$	$\overline{29}$ 47	76 14	$\overline{29}$ 46	76 14	17
*X**	$\bar{4}81$	$\overline{30}$ 3	82 59	$\overline{30}$ 1	83 2	6
λ	$\bar{2}\cdot18\cdot3$	$\bar{6}$ 57	79 26	$\bar{6}$ 57	79 25	9

From the co-ordinate angles given in the above table some of the principal interfacial angles were calculated,

and in the following table these are placed alongside the corresponding angles derived from the elements of Schrauf and Farrington respectively; there is, it will be noticed, a striking agreement between the angles for the Arizona and Mineral Hill azurites.

Angles on *c* (001).

Form.	Anderson.		Farrington.		Schrauf.	
	°	′	°	′	°	′
a (100)	87	35	87	37	87	36
m (110)	88	10	88	11	88	10
w (120)	88	47	88	48	88	47
l (023)	30	33	30	33	30	24
f (011)	41	31	41	31	41	21
p (021)	60	32	60	33	60	24
σ (101)	44	42	44	44	44	46
φ (201)	62	14	62	16	62	18
θ ($\bar{1}$01)	47	11	47	12	47	15
η ($\bar{3}$02)	58	53	58	53	58	56
v ($\bar{2}$01)	66	9	66	8	66	11
P (223)	41	23	41	24	41	21
s (111)	52	30	52	31	52	28
h (221)	68	13	68	14	68	12
γ (121)	63	1	63	2	62	56
k ($\bar{2}$21)	71	27	71	26	71	25
R ($\bar{2}$41)	77	27	77	26	77	24
X ($\bar{4}$81)	84	15	84	14	84	13
λ ($\bar{2}$·18·3)	79	43	79	43	79	40

Angles on *b* (010).

Form.	Anderson.		Farrington.		Schrauf.	
	°	′	°	′	°	′
m (110)	49	25	49	26	49	38
w (120)	30	17	30	17	30	28
h (221)	52	50	52	49	53	1½
γ (121)	39	40	39	40	39	51½
s (111)	58	55	58	55	59	5
P (223)	64	31	64	31	64	40
λ ($\bar{2}$·18·3)	12	38	12	38	12	42½
R ($\bar{2}$41)	32	32	32	33	32	45
k ($\bar{2}$21)	51	51	51	53	52	7
X ($\bar{4}$81)	30	44	30	44	30	57½

Angles on a (100).

Form.	Anderson.		Farrington.		Schrauf.	
	°	′	°	′	°	′
P (223)	57	47	57	48	57	42
l (023)	87	55	87	56	87	56
s (111)	51	8	51	8	51	1
f (011)	88	11	88	12	88	12
h (221)	43	56	43	56	43	$45\frac{1}{2}$
γ (121)	62	7	62	7	61	58
p (021)	88	49	88	50	88	49
k $(\bar{2}21)$	134	53	134	55	135	5
λ $(\bar{2}\cdot18\cdot3)$	96	50	96	50	96	53
R $(\bar{2}41)$	118	50	118	51	119	2
X $(\bar{4}81)$	119	46	119	47	119	59

Summary.

Fine crystals of azurite, accompanied by cerussite and malachite occur in the oxidised zone of the Iodide Mine, Mineral Hill, near Condobolin, New South Wales. A total of twenty-one forms of which X $(\bar{4}81)$ is new, were found on the crystals, which are characterised by two different habits. The measured angles are not in agreement with the standard values as given by Schrauf, and new elements

$$a : b : c = \cdot85721 : 1 : \cdot88581, \beta = 87^\circ\ 34\tfrac{1}{2}'$$

have been calculated. When comparison is made between Schrauf's elements for the azurite of Chessy and those derived by others for the azurite from various localities, it is found that Schrauf's a and c axes are distinctly shorter.

Description of Plates.

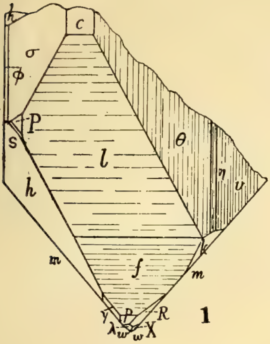
Plate V.

Fig. 1. Crystal 5; orthographic projection on the plane of the a and b axes, crystal shown in its actual development.

Fig. 2. Crystal 5; orthographic projection of Fig. 1 on the plane of the a and c axes.

Fig. 3. Crystal 5; Fig. 2 idealised.

Fig. 4. Crystal 2; orthographic projection on the plane of the a and c axes, ideal.



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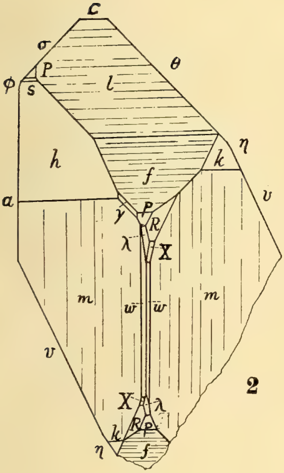

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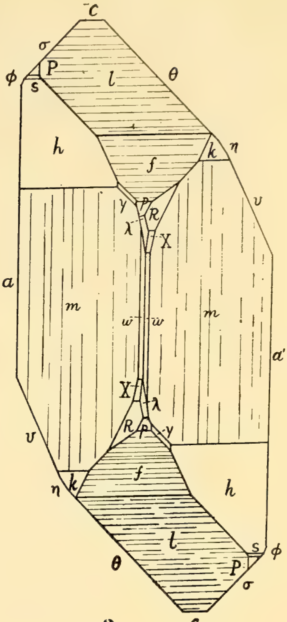

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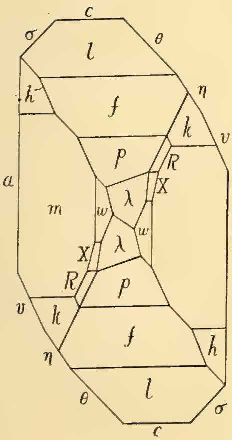

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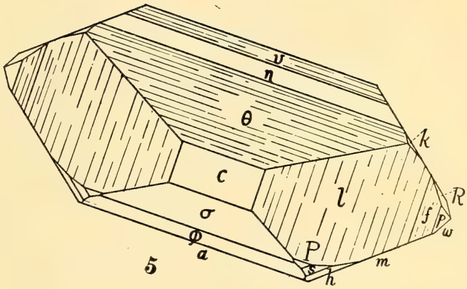

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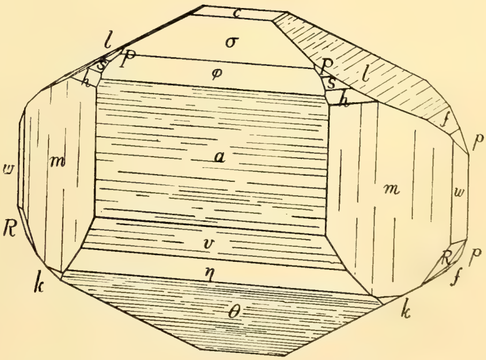

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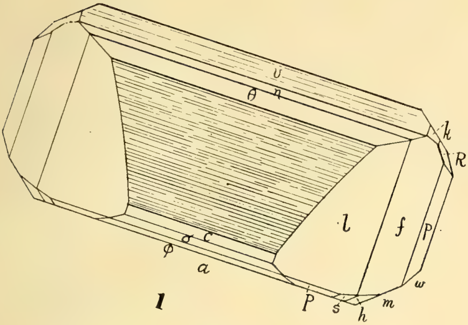
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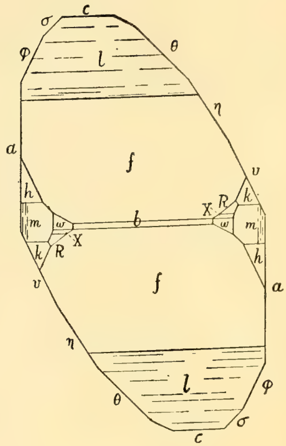
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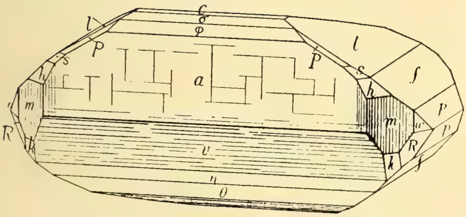
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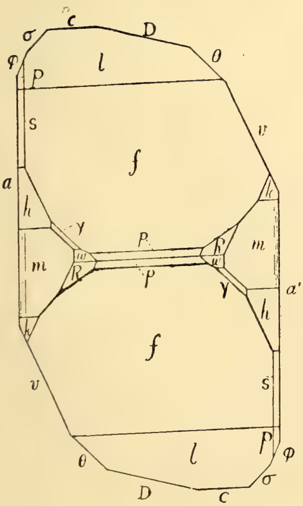
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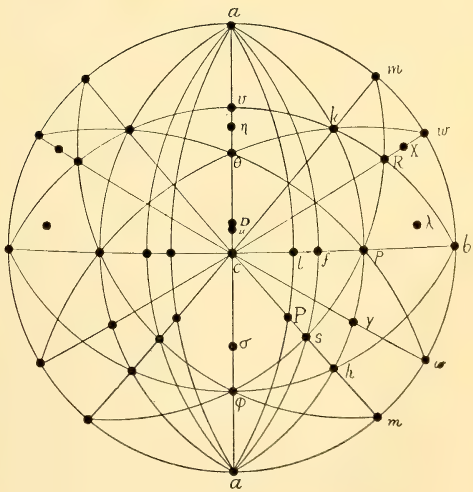
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5 C. A., *del.*

Fig. 5. Plan of Fig. 6.

Fig. 6. Crystal 3; clinographic drawing, ideal.

PLATE VI.

Fig. 1. Plan of Fig. 2.

Fig. 2. Crystal 15; clinographic drawing, ideal.

Fig. 3. Crystal 8; orthographic projection on plane of *a* and *c* axes, ideal.

Fig. 4. Crystal 17; orthographic projection of plane of *a* and *c* axes, ideal.

Fig. 5. Stereogram; the doubtful forms D ($\bar{1}04$) and μ $\bar{1}05$ are included (the zone circles $b\gamma s\sigma$ and $wh\sigma$ are inadvertently omitted with drawing).

TOPOGRAPHICAL, ECOLOGICAL, AND TAXONOMIC NOTES ON THE OCEAN SHORELINE VEGETATION OF THE PORT JACKSON DISTRICT.

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[With Plates VII - XIII.]

[*Read before the Royal Society of N. S. Wales, October 3, 1917.*]

THE floristic region reviewed in these notes runs coastally from Turrimetta Head to Port Hacking, and stretches inland a few hundred yards from the Pacific Ocean. Within this zone we have the customary strand, alternating with bluff headland and rocky escarpment. At the rear of the various beaches sand-dunes rise into more or less steeply graded embankments of varying height, with, usually, an uneven plateau above extending to a valley running parallel to the beach, and which is sooner or later excavated by atmospheric pressure, the rearward slopes continuing until

the frequently occurring lagoon or the general contour level is reached. The northern section of the shoreline consists of Narrabeen Shale superimposed on the reef. Throughout this area in which the soil is comparatively rich, the indigenous vegetation has been removed, and the ground dedicated to a pasture of "Couch-grass" *Cynodon dactylon* Rich., which creeps out to the verge of the ocean headland or the dune embankment.

South of Deewhy the shale is replaced on the headland by the coastal sandstone. The broken escarpment, and the shelving parapet immediately above, are sparsely clad or frequently quite bare, a shallow layer of soil finding a lodgment here and there in depressions of the rock benches, or filling pockets and crevices in the reef, and supporting a scanty, storm-bitten vegetation. On the rocky hillside the plants are chiefly shrubby, most of the herbaceous species, with the exception of *Glumiferæ*, retreating inland or descending to the dune. The vegetation on the dune front is largely herbaceous, though several shrubby species reach the plateau of the embankment. The bulk of the ligneous vegetation does not, however, venture within range of the periodic storm visitation, which denudes the frontal embankment and deposits its spoil on the rearward slopes. The frontal dune slopes are scantily furnished, and competition between the scattered plant colonies is consequently limited, permitting, in many instances, fairly large areas of a practically pure specific formation. Occasionally, however, especially among the rhizomatic species, two or more struggle for supremacy, and frequently the individual competition within the colony is exceptionally severe.

The gregarious sylvatic species on the rearward slopes, have generally adopted an open forest formation, in which a thick undergrowth finds protection, a notable exception

being provided by the "Coast Tea-tree" *Leptospermum lœvigatum* F.v.M., which is frequently assembled in a close formation, occasionally so densely packed as to exclude all except liane growth, or a few exceptionally shade-tolerating species. This habit is simulated by *Casuarina suberosa* Otto and Dietr., which, on the headland at Cronulla, has formed so close a thicket that the only intruder on its privacy is the creeping *Hydrocotyle hirta* R. Br. Of these arboreal societies, *Banksia integrifolia* L. f. occasionally extends in belt formation, *B. serrata* L., *Melaleuca leucadendron* L. var. *albida* (Sieb.) E. Cheel MS., (*Melaleuca Smithii* R. T. Baker), *Eucalyptus corymbosa* Sm., etc., usually forming clumps or groves. Two arboreal species are confined to the rocky hillside, the remainder of the sylvatic vegetation bestowing equal favour upon dune and headland.

The principal factor affecting the vegetation on the seaboard, is the on-shore wind, whose mechanical action retards arborescent growth and induces nanism, its sustained attack compressing the shrubs on the exposed front of the dune embankment, or rocky headland, into a horizontal growth. Its capacity for quickly carrying off moisture, promotes rapid transpiration, resulting in the survival of plants with a xerophytic equipment. The wind also minimises the stability of the soil by erosion, and transportation, the dune vegetation in the region of exposure responding by trailing, or spreading a carpet closely appressed to the soil, by deep taprooting, or by framing a rhizomatic network. The latter device also serves as a protection against displacement by flood-waters, and acts as a deterrent to the intrusion of fugitive plants. A considerable share of the root ramification may also be debited to the necessity for covering an extensive field of this inhospitable region in search of a suitable food supply, the

littoral sand containing little humus, and affording indifferent nourishment to the vegetation.

The xerophytic device most favoured by the herbaceous plants on the frontal dune slopes is succulence,—aqueous tissue—the shrubs at the rear, and those on the rocky headland, adopting various forms of leaf modification, heathlike, crass or leathery, clothed more or less thickly with a felted vestiture, or waxy coating, and with variously arranged and protected stomata. The frontal slopes of the dune receive the salt-laden spray from the ocean, and are consequently halophytic, but the xerophytic character of the vegetation on the inner slopes is due to the physical factors with a desiccating tendency operating in this region, rather than the effects of a superabundance of sodium chloride in the soil.

The principal colonisers on the strand are aliens, more or less suspected introductions, cosmopolitan species, or plants with an extra-Australian range, many of which have been brought to our shores in ships' ballast, which has been dumped on several of our beaches and spread thence along the coast. Stockton Beach at Newcastle, and Geelong on the shores of Corio Bay, Port Phillip, are both well known nurseries for alien weeds. In an interesting account of the Flora of Coode Island,[1] Mr. J. R. Tovey notes that a portion of the island has been used as a dumping ground for ships' ballast, and, as a consequence, the flora is now almost entirely exotic. Mr. Tovey mentions, *inter alia*, that many of the exotic species on the island are natives of South Africa, and a similar occurrence of natives of that country was noted among the dune flora of the Port Jackson district. Many of these plants are provided with fruits whose seeds are enclosed in suitable vessels for maritime voyaging. The structure of the fruits is primarily designed for buoyancy,

[1] Vict. Nat., Vol. xxviii, p. 57 (1911).

their coats are usually of a corky, or woody texture, and they have one or more watertight compartments, which serve the purpose of floats, and act as a protective agency against the intrusion of the saline water. A by no means insignificant factor in the moulding of the fruit, is the danger of being dashed to pieces by the waves upon a rocky headland, or ground to powder on a shingle beach, while *en voyage*. The most suitable contrivance to neutralise the effects of such an occurrence, is the production of strengthening ribs, which are frequently extended into wing-like appendages, or, in the Spinifex, an elongated spine (awn) proceeding from the apex of the fruit, which act as collision buffers.

[In the scientific portion of his Presidential Address to the Royal Society, "An Ecological Sketch of the Sydney Beaches,"[1] Mr. Charles Hedley cites a series of devices adopted by certain molluscs, characteristic of the rocky surf-swept headland; in the construction of their dwellings, by which the sculpture of the shell is so contrived as to produce extensions or projections, calculated to strengthen its resistance to wave action, and figures (p. 57, fig. 19) such a shell, armoured with massive rings.]

The material of which the fruit coat is composed, corky, pithy, felted, membranous, etc., is of a tough but yielding character, not easily fractured. The members of the strand community are as a rule prolific seed bearers. Two grasses, *Spinifex hirsutus* Labill., the "Spiny Rolling-grass," and the littoral "Fescue," *Festuca littoralis* Labill., play an important part in the building and upkeep of the frontal dune embankment rising immediately behind the strand, the former, in the area inspected, representing approximately 50% of the herbage clothing its slopes.

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[1] This Journal, XLIX, (1915).

[In "Shoreline Studies at Botany Bay,"[1] E. C. Andrews, B.A., F.G.S., has demonstrated the capabilities of the Spinifex as a sandbinder, in a diagram p. 169, depicting a "Terrace of accumulation," at Lady Robinson's Beach.]

On the beaches which it has specially favoured, the trailing stems of this diœcious grass, (the best of our indigenous sandbinders), creep out from the plateau above, and invest the steep unstable slope to its base, frequently intruding on the strand below. Its flexible stems, which root at every joint, roll elastically from side to side under the pressure of the wind, permitting the moving sand to accumulate beneath them, and bestriding the drift to hold it in position. The stems are assisted in the work of building and retaining the embankment, by the upright tufts of leaves, which rise from the joints above the roots, around which the sand forms miniature mounds, the leaf tufts working upwards as the sand rises.

The *Spinifex* is eminently adapted to contend with the adverse conditions inseparable from a strand environment. Its stems are succulent, and together with the leaves are clothed with a shaggy vestiture, the latter are involute in form, and fibrous in texture, a series of characters which provide a maximum of resistance to the attack of the sharp-edged storm-driven sand grains, the desiccating effects of the superficially heated sand, and the presence of an undue quantity of sodium chloride in the soil.

To its colleague, *Festuca littoralis*, is allotted the pioneer work of embankment building and restoration. When operating in a frontal position, the Fescue forms isolated tufts on the beach at the base of the embankment, occupying any vantage points presented by the buttressing sand-ridges at its base. Dotted here and there on the otherwise bare surface, each tuft forms a mound from the sand caught

[1] This Journal, L, p. 165 (1916).

by the eddy which its presence creates. At this stage the plant makes use of its capacity for vertical movement only, rising with the sand and producing a secondary root system on the stem (adventitious) at a distance from the base, in conformity with the measure of the drift. When the stem is securely rooted in the new position, the lower portion, together with the old root attachment is discarded, and eventually decays, adding a modicum of humus to the sand. The mounds eventually become confluent at the base, and the Fescue travelling laterally by means of its horizontal rhizomes, connects them, forming them into a low bank. Concurrently with the movement of the Fescue, the Spinifex has felt its way down the slope towards its associate, and these tireless builders meet and join forces in the work of reclamation. When engaged in the rehabilitation of the storm blown sand banked up on the rearward slopes, which has buried the previously existing vegetation, the Fescue brings both vertical and horizontal thrust into play, forming a series of elongated ridges, running parallel to the strand, and which are finally merged into a second embankment, with the usual valley lying between it and the frontal slope.

Of the species enumerated 10 are endemic in the Port Jackson district; 4 extend to the Blue Mountains; 45 are found in New South Wales only; 5 in New South Wales and Victoria; 18 in New South Wales, Victoria, and Tasmania; 4 extend from New South Wales to South Australia; 3 from New South Wales to Western Australia; 33 occur in both Queensland and New South Wales; 48 in Queensland, New South Wales and Victoria; 35 extend from Queensland to South Australia; 24 from Queensland to West Australia; 8 from North Australia to New South Wales; and 2 are found in all the Australian States. Known and suspected aliens number 25 and there are 55 species—indigenous and alien—with an extra Australian range. 45% of the whole

are confined to New South Wales and the two neighbouring States. The preponderance of species extending north, over those found south of Port Jackson, is at least 25% in favour of the northern localities. The oversea species—indigenous and alien—are chiefly beach-dune plants. The absence of bulbous plants from the shoreline is particularly noticeable. Most of the plants noted approach within one hundred yards of the strand on the dunes, and a similar distance from the shoreline on the headland. The specimens mounted to illustrate this paper will be presented to the National Herbarium.

Southward from Turimetta Head, Long Reef Beach, locally named Collaroy Beach, enters upon a comparatively flat area bare of vegetation, such as is usually found at either end of the ocean beaches, which is here bisected by the channel at the entrance to Narrabeen Lake. From the southern margin of the stream, the dune embankment rises with an easy grade, the sand waves at its base beset by outlying trailers of Spinifex, among which are sprinkled a few tufts of *Festuca littoralis*. Prominent on the crest of the embankment is the bunchy *Xerotes longifolia* R. Br., a ubiquitous species which can accommodate itself to an exposed position on the seaboard, or a bald ridge on the highest elevations of the Blue Mountains, and is equally at home in a sheltered nook in a rich southern Illawarra brush. On the dune front it frequently chooses the crown of a knoll, or the saddle of a ridge, upon which to found a colony. In such situations the plants are closely packed, those in the centre of the cluster uplifted by the pressure of their brethren in the outer ring. On the sheltered rearward slopes the plant clusters, though retaining the gregarious habit, are more open, the necessity for a close formation disappearing with the reduction of exposure. The tough, leathery consistence of the leaves renders frequent renewals unnecessary, their persistence imposing a minimum strain

on the weak root system, whose limited area of activity is not conducive to the accumulation of either food constituent, or water supply. The rigid, flattened flower stem, is structurally adapted to carry the heavy panicles of fleshy flowers.

Its frequent associate on the dune, *Hibbertia volubilis* Andr., is a trailer, or twining climber, as befits the situation. When growing on the ridges and spurs of the broken dune front, its running stems turn inwards and become interwoven, building up the plant into a hummocky form. On the protected slopes at the rear, its movements are less restricted, and it here assumes a diffuse, or scrambling habit. Bentham, Fl. Austr. i, 37, notes this species as climbing to a height of 2 – 4 feet, but under the dense canopy of a close shrubbery, such as that afforded by a grove of "Coast Tea-tree," its climbing habit is fully developed, and in such a habitat on the shore of Botany Bay, it was noted ascending the Tea-tree to a height of 12 – 15 feet in search of the light. It has a coastal range from Milton, north into Queensland, but has only succeeded in ascending the dividing range, in New England, where it has reached the tableland. In the Port Jackson district it extends inland to Parramatta.

A congener, *H. diffusa* R. Br., a prostrate, twiggy shrub, occasionally ventures on the dune flats, but its greater frequency on the grasslands and hillsides, removed from the littoral, demonstrates its preference for such situations. At this (northern) end of the beach, *Convolvulus soldanella* L., a sea coast habitue in most extratropical countries, is sparsely represented. To secure stability in the mobile sand, it has developed an intricate system of subterranean creeping stems, (stolons) radiating from the rootstock, upon which it depends for fixity of tenure. It will occasionally descend the frontal embankment, where the gradient

is not too severe, but is much better suited on the plateau above.

At the southern end of the beach, where it commences to curve towards the shelter of Long Reef, the Convolvulus has run along the edge of the embankment plateau in a confluent patch, two or three hundred yards long and a few yards wide. The glossy upper surface of the leaves marks the course of the plants along this stretch of the dune, their waxy coating affording them a measure of protection from direct insolation, as the broad leaves lie flat on the sand presenting the whole of their upper surfaces to the sun's rays. On the open dune this herb is a prostrate trailer, but under suitable conditions it displays the climbing tendency common to the family (Convolvulaceæ).

Another prostrate herb, also symptomatic of the sandy sea coast, and occupying a similar position on the dune, is *Euphorbia Sparmanni* Boiss. It is one of the deep rooting members of the dune fraternity, and forms a more or less circular carpet by means of its radially branched stems, which lie closely appressed to the sand. Though not widespread, it is a useful addition to the vegetation on the dune front. The plants are usually isolated, but occasionally a few are observed associated in a small colony. In common with other members of the family (Euphorbiaceæ), it secretes a milky latex, a useful xerophytic provision.

In the valley behind the frontal embankment and parallel to it, the vegetation is sheltered. *Correa alba* Andr., the "Cape Barren Tea-tree" of Tasmania, here assumes a comparatively open habit, displaying its normal depressed conical contour. In exposed situations on the frontal dune embankment, it is frequently compressed by the wind into a dense shapeless mass of tangled branches. It has crass, tough leaves, clothed with a felted tomentum on the under surface, the upper side less thickly covered, and with a

varnished coat, the latter serving the dual purpose of deflecting the storm-blown sand, and the direct solar rays. This species is recorded in the Fl. Austr. i, 354, from Victoria, Tasmania, and South Australia. The omission of New South Wales is obviously a clerical error, as Bentham, *loc. cit.*, refers t. 515, Bot. Reg. to this species. The plate is given as *Correa alba*, "White Correa," or "Botany Bay Tea-tree," and the habitat of the plant depicted as New South Wales.

The "Pig's-face," *Mesembryanthemum æquilaterale* Haw., finds in the valley a congenial habitat, where—either individually or collectively—it forms large carpets, the plump succulent leaves, and generally healthy appearance of the plants, demonstrating their appreciation of the shelter afforded. As it approaches the strand, the area of the carpet and bulk of the foliage, diminishes in proportion to its proximity to the region of exposure. Environment has in this case affected the whole plant, leaves, stems, and even the fruits responding to the demand for water conservation, by becoming succulent, the imprisoned moisture incidentally adding weight to the carpet and strengthening its resistance to displacement by the wind.

The deep-rooting *Pelargonium australe* Willd., is occasional on the frontal dune slopes, more plentiful on the embankment plateau, but attains its greatest frequency and scope of ramification in the sheltered dune valley. In exposed positions, its rotund leaves spread in a circle, with the lamina turned outwards, and held in a vertical position at a distance from the stem by the elongated petioles, the overlapping whorls forming a close rampart. When the shifting sand bares the rootstock the basal leaves droop, shading and protecting the roots, and encouraging the reaccumulation of the sand by acting as a barrier to its drift. The thickened rootstock is sufficiently firm to support

the surface growth during the period of exposure, and in conjunction with the exceptionally deep tap-root acts as a reservoir for food and moisture. It is more frequent on the dune than on the rocky headland, favouring the latter habitat in places where the sand has accumulated to some depth, or in the soil pockets where the tap-root can accomplish its normal descent. The maritime forms are generally more luxuriant than those growing at a distance from the coast.

Stephania hernandifolia Walp. on the open dune is a trailer, but in its customary habitat in the coastal scrub its climbing habit is asserted. Climatically it is an adaptable species, ranging from India to the southernmost parts of Victoria, viâ the Australian coast.

A consequential member of the dune valley vegetation is the "Lilly Pilly," *Eugenia Smithii* Poir., which generally adopts a more or less open grove formation. On the headland its tendency to avoid exposure is manifested in its choice of position, which is usually on the northern (sheltered) side of the point, or, as on the dune, in a depression.

The blue flowered trailer *Commelina cyanea* R. Br., though capable of withstanding a considerable degree of exposure, as its presence on the bluff rocky escarpment indicates, prefers a sheltered shady situation such as that afforded by a Lilly Pilly plantation. When unprotected by shrubby or arboreal vegetation it seeks moisture, a swampy patch on the rock benches, or the verge of a waterhole where it can creep among the rushes and sedges, presenting an ideal habitat. It reaches the Northern Territory coastally, and is not recorded south of the Port Jackson district.[1]

A miniature forest of the "White Honeysuckle," *Banksia integrifolia* L. f., extends along the dune flat on the land-

[1] This species was recently noted by the Government Botanist, Mr. J. H. Maiden, at Sussex Inlet, and by Mr. R. H. Cambage at Milton.

ward bank of the valley, following its course in belt formation until it merges into the dune flat, a few straggling trees crossing the dune in Indian file, the outermost reaching the embankment plateau and extending to within a few yards of the strand. Under cover of this arboreal shelter, several adventurous shrubs have reached the dune valley, which do not, except under very favourable circumstances, approach so closely to the strand. Of these, *Marsdenia rostrata* R. Br., a plant with a lengthy coastal range, and recorded from several elevated stations on the Blue Mountains, is here represented by an individual specimen, the only one noted on the shoreline. A climber in the brush forest,—its customary habitat—it has here adopted a matted habit, and spreads outwards for some distance, establishing its position by smothering the undergrowth in its vicinity. A few bushes of the soft, porous wooded, *Clerodendron tomentosum* R. Br., have taken advantage of this opportunity to press forward into the valley. Though not a strictly halophilous species, it is frequently found in the vicinity of tidal waters. Another small group of these plants was noted on the rocky hillside—facing north—at the southern end of Manly beach.

A large leaved form of *Notelœa ovata* R. Br., a species which extends from Illawarra to Queensland, has here found its way through the *Banksian* forest into a frontal position in the valley.

The "Port Jackson Beech," *Monotoca elliptica* R. Br., and *Breynia oblongifolia* J. Muell., also attain, in this valley, their closest proximity to the strand. They are both more or less dependent—in this situation—on the surrounding vegetation for protection, neither venturing alone on to the frontal dune slopes. On other parts of the shoreline, the "Beech" exhibits a preference for a *Banksian* association, the White and Red Honeysuckle forests being

specially favoured. *Breynia oblongifolia* has no preferential associates, but is content to mingle with any vegetation which provides a modicum of shade and shelter. Both species frequent the rocky hillsides on the ocean front, maintaining a respectful distance from the verge of the escarpment.

Further south the valley shallows, and *Wikstrœmia indica* C. A. Mey., a soft-wooded halophytic shrub, constitutes a considerable proportion of the vegetation. In this station the *Wikstrœmia* attains its greatest profusion, extending inland for some distance on the dune flat. Occasional clumps were met on all the beaches south to Manly, but it was not noted south of Port Jackson.

Towards the southern end of the beach the shelter afforded by the Long Reef promontory becomes effective, the lowering of the dune embankment, and the merging of the valley into the plateau, demonstrating its influence in moulding the contour of the beach. On the plateau in close proximity to the strand, the introduced "Cat's-ear," *Hypochœrus radicata* L., has established a colony, the large, closely appressed, basal rosettes of the plants, enabling them to support the elongated branching stems in an upright position. Into this association several plants of the weedy crucifer, *Lepidium hyssopifolium* Desv. (one of a number of species included by Bentham, Fl. Aust., i, 86, under *L. ruderale* L.) have intruded. In their immediate neighbourhood several bushes were noted of the spiny "Wild Tomato," or "Apple of Sodom," *Solanum sodomœum* L., from the Mediterranean littoral, one of the hardiest members of the dune flora.

In this comparatively sheltered situation its behaviour is normal, but when growing in a position, frequently chosen on the windswept crown of a hillock, or the verge of the exposed frontal embankment, where its upright growth is

retarded, it spreads trailing branches to retain the sand in its vicinity and intercept the drift from the beach, using the collected material as a support for its heavy limbs, and relieving the ascending stem of the burden of supporting the unwieldly lateral growths.

One of the twiggy "Salt-bushes," *Rhagodia Billardieri* R.Br., is prevalent on the dune flat. Plants of this species when standing alone, build up a divaricately branched, hedge-like structure, but when growing in the vicinity of stout upright shrubs, they invest them, trailing over their stems and branches. One of these plants was noted to have covered the trunk of a dead *Banksia* to a height of eight feet. On the dune it usually coats its leaves with a waxy varnish, but on the rocky escarpment of the headland this protective device is not so much in evidence, and is occasionally—in very exposed situations—replaced by a mealy tomentum.

The cosmopolitan "Couch-grass," *Cynodon dactylon* A. Rich., spreads a closely matted lawn on the plateau, creeping out to within a few yards of the edge of the dune embankment, the "Buffalo-grass," *Stenotaphrum americanum* Schr., forming a flanking carpet, or, in places where garden refuse has been tipped, intruding on the Couch. In the frequent encounters between these two favourite lawn grasses, the question of supremacy is decided by the quality of the food supply, the quantity of moisture available and the physical condition of the soil. On the impoverished permeable sandy soil of the dune, the Couch will hold its own, but in the stiff clayey soil of the Wianamatta Shale the stouter subterranean stems of the Buffalo overpower the slender rhizomes of the Couch, and its broad heavy flag will exclude the light from the weaker grass, and eventually suppress it.

Though both grasses advance to the front of the dune plateau, they cannot, either singly or in association, main-

tain a position at its extremity, always retreating from the rapidly eroding verge of the embankment, if not protected by hardier vegetation. One of these protective plants is the "Coast Couch," *Zoysia pungens* Willd., a creeping grass similar in habit to the common Couch, but possessing a greater exposure resistant capacity, as demonstrated by its proximity to the beach, its short, dark coloured flower spikes always showing prominently in front when these two grasses are associated—a common occurrence—and attaining a position prohibitive to *Cynodon*. This association is continued on the rocky escarpment of the headland, the *Cynodon* in places creeping down the rock-strewn hillside to within a few yards of the bare parapet above the cliffs, when the *Zoysia* again asserts its beneficent influence, and accepts the brunt of the exposure.

The frontal embankment from the point of emergence of the dune valley to the southern end of the beach, is intermittently fringed by another creeping grass *Sporobolus verginicus* Humb. and Kunth., a frequenter of the salt-marsh and estuary rather than the strand. The upright branches rising from the decumbent stems are normally slender and graceful, with distant convolute leaves. On the ocean front, on either dune or rocky escarpment, it presents an unkempt appearance arising from a malformation of the infertile stems, which are dilated and crowded, simulating a distichous arrangement though the leaves are alternate. The flowering branches were not observed to be subject to this disability.

The "Sour-grass," *Oxalis corniculata* L., a shallow rooting creeper, of annual growth in cold regions, which responds to the mild conditions in this district, by attaining a biennial, or even longer duration, is an exceptionally adaptable species. It exercises little or no discrimination as to soil, climate, elevation etc., contenting itself with

regulating the dimensions of its leaves and carpet, to meet the varying conditions obtaining in its ubiquitous habitat. On the dune it reaches the frontal slopes, displaying a preference, here as elsewhere, for association with a "Couch" lawn, but is capable of maintaining its individuality on the bare sandy plateau.

In a frontal position on the dune flat, the "Salt-wort," *Salsola kali* L.,—found on the shores of most temperate countries—was represented (November) by numerous groups of seedlings, springing up among the rapidly withering stems of the parent plants. The adolescent plants are leafy, but can only maintain the foliar character for a brief period, reducing it when they reach the adult stage to a mere wing-like, spine tipped, outgrowth (cladodium) on the succulent stem and branches. The latter are interwoven into a divaricate framework, stayed and supported to prevent dislocation and consequent fracture, of the heavy brittle limbs. The interior form of this species, the "Roly Poly" of the Western Plains, is less succulent and more spiny, and retains its foliage to a much later stage. On the exposed ocean beaches the "Salt-wort" is not as plentiful as on the sheltered harbour beaches, *e.g.*, the eastern shore of Botany Bay, where it was collected by Banks and Solander in 1770. The fact of its presence previous to the advent of these eminent botanists, is a measure of evidence that it is not an alien in Australia.

The 'Travellers' Joy,' *Clematis glycinoides* DC. occasionally crosses the dune flat to the frontal embankment, where in the absence of supporting shrubby growths, it forms a tangled thicket. It is a typical example of the petiolar group of climbers, and when growing in its customary station in the scrub, its running stem ascends the trunk of an arboreal neighbour, and throws a leaf over a convenient branch. The tendril-like leafstalk coils itself with one or

more spirals round the branch, securing a foothold from which the climbing shoot advances to a higher plane, the pendulous stems eventually festooning the shrubs in the immediate vicinity.

A perrenial *Sonchus* (under review), is sparsely sprinkled among the Spinifex trails, or dotted on the bare dune slopes. This deep-rooting species has adopted both sexual and vegetative methods of reproduction, the former for distributive purposes (seeds), and the latter as a colonising agency (offsets). The young plants spread outwards encircling and protecting the parent plant, and maintaining it in an elevated position in the centre of the cluster.

A widely distributed extra-tropical "Rush," *Scirpus nodosus* L., is the most prominent Cyperaceous plant on the shoreline. It advances to the frontal dune slopes and is frequent on the plateau, its solitary tufts rising from the bare sand or turf lawn, imparting a marked feature to the dune landscape. Its intricate system of stout, wiry, strongly jointed rhizomes, provides a foundation upon which the closely packed superstructure of elongated stems is secure from overthrow by the fiercest storm blasts. It is equally in evidence on the rocky escarpment and headland, in sand-patches, soil-pockets and rock crevices.

The dune embankment which has gradually lowered is now merged into the beach. The sweep of the curve towards Long Reef is interrupted by the intrusion of a bluff, on whose rocky escarpment the trailing stems of *Kennedya rubicunda* Vent., and the "Egyptian Bind-weed," *Ipomœa palmata* Forsk., are interlaced. The latter is the *Convolvulus cairicus* of Linnæus, a dedication (specific) to the ancient city of Cairo, where it has been cultivated for many centuries. Though a trailer on the rocky escarpment, it does not descend to the dune, it is normally a climber. In a paper on the "Flora of Norfolk Island,"[1] Mr. J. H. Maiden says:

[1] Proc. Linn. Soc. N. S. Wales, Vol. xxviii, p. 692.

"It is found all over the island climbing the highest trees." At Kurnell, near the landing place of Captain Cook, it was noted climbing trees of *Banksia integrifolia*, and this is doubtless the source from which Banks and Solander collected their specimens, a sheet of which is now incorporated in the National Herbarium collection. It has not, so far as I can ascertain, been recorded south of Port Jackson, but we have specimens in the National Herbarium collected by Mr. A. H. S. Lucas at Jervis Bay, 7, 1899, and by Mr. R. H. Cambage at Ulladulla, No. 4174, 12, 1915.

Associated with these trailers was the prostrate herbaceous *Hibiscus trionum* L., the "Bladder Hibiscus" of Europe. Its flowers are short lived, opening for a few hours only. It was not seen elsewhere on the shoreline, but its occurrence in the vicinity of the beach is not unusual. The indigenous vegetation, with the exception of a few scattered trees of *Banksia integrifola*, several of which occupy positions on the extreme verge of the bluff, has been removed from the top of the headland and the ground turfed with "Couch," which creeps down the slopes of the overlying Narrabeen Shale until it reaches the rocky escarpment at the base, where it finds its associates of the dune *Sporobolus virginicus* and *Zoysia pungens*, fringing the rock benches.

Beyond the bluff the beach narrows, the dune embankment rising abruptly from the strand, its verge indifferently protected by the remnant of the native flora. On the northern slopes of Long Reef point, isolated specimens of *Banksia integrifolia* find a somewhat insecure foothold on the ridges, the trees dwarfing as they reach the line of exposure on the ocean front. [The winds most injurious to the vegetation on the shoreline come from the south, and the northern slopes of a promontory or headland are more or less protected from its visitation].

The broad benches of the rocky escarpment are thinly coated with a layer of soil, (Narrabeen Shale) eroded from the embankment above, on which two grasses, *Imperata arundinacea* Cyr., "Blady-grass," and *Themeda Forskalii* Hack. var. *imberbis*, "Kangaroo-grass," have established colonies. Both species form gregarious communities, the former linking up its members by their subterranean stems, and the latter binding its closely packed tufts by interlacing their ærial stems. Though the communal bond is a palpably useful device in this unstable environment, it does not appear that these plants have adopted it with a view to the conquest of this territory, as both species act in a similar manner in situations where the soil is perfectly stable, though in the latter case the tufts of the "Kangaroo-grass" adopt a more open formation. It is evident that the survival of these grasses, in this exposed position, is due to the suitability to the prevailing conditions of their ordinary habits and structure. A few clumps of the cosmopolitan *Juncus effusus* L., are present in the moist rock crevices. It does not favour the dry dune slopes, its massed formation on the margin of the beach lagoon disclosing its preferential habitat. The taller species of *Juncus*, *(Junci genuini)* are exceptionally plastic, and owing to the paucity of fixed morphological characters are difficult to separate.

At the extremity of the promontory, the steep bluff, and the easily eroded shale of which it is composed, have, in combination, created a situation so detrimental to plant life that the slope is almost bare. Two trailers, *Kennedya rubicunda* Vent., and *Wedelia biflora* DC., are the only inhabitants of this inhospitable region. The former extends to the coastal tableland but the latter is confined almost exclusively to the shoreline. Its habit of scrambling among hedges and rocks near the sea side, is noted by Bentham in the "Flora Hongkongensis," p. 163. Beyond the point the

dune formation reappears, and a little further south the shoreline again alters, the bare embankment facing the ocean disclosing the local shale. Two shrubby species occupy prominent positions on its verge, the "Coast Rosemary," *Westringia rosmariniformis* Sm., and the "Coast Tea-tree." The former is rarely found more than a few hundred yards inland, and exhibits a preference for the headland rather than the dune. Its associate, on the contrary, reaches its optimum on the dune, though it occasionally forms by no means despicable colonies on the more sheltered parts of the rocky hillside.

The root system of young plants of the Coast Tea-tree growing on the dune is chiefly lateral, the tap-root in the example exhibited measuring 4½ inches, the laterals reaching a length of 18 inches. This arrangement is due to the fact that the modicum of humus in the dune soil is superficial, the roots spreading in the direction of the food supply. In a comprehensive article on "Sand-drift Problem in New South Wales,"[1] the Government Botanist, Mr. J. H. Maiden says of this species, (p. 988), "Let me particularly emphasise the value of *Leptospermum lævigatum*, Nature's special sand-stay for many parts of coastal New South Wales."

At the southern end of the headland the escarpment descends with a steep grade to Deewhy Beach. Two undershrubs were noted on its slope, *Acacia myrtifolia* Willd., and *Styphelia humifusa* Pers., the prostrate Ground Berry, neither of which is found on the frontal dune slopes. The waters of the lagoon behind the beach have overflowed in several places, and formed broad shallow drainage channels across the dune, extending to the strand. In this moist area the sand or mud creeper, *Bramia indica* Lam., has formed large carpets, connected throughout by its creeping stems. Associated with it is a diminutive

[1] Agric. Gazette N. S. Wales, Vol. XVII, p, 975.

sedge, *Scirpus cernuus* Vahl., which contributes a measure of assistance to the communal effort to secure stability by means of its ramifying stolons.

At Port Hacking, *B. indica* was recently noted associated with another mud-creeping member of the same family, *Mimulus repens* R. Br., the "Creeping Monkey Flower." The former, which had not previously been recorded south of Parramatta, is a common marsh plant in most tropical countries, and, as is the case with many widely distributed species, has acquired an extensive synonomy. The climatic boundaries of these two species overlap in New South Wales from the northern rivers to Port Hacking, *M. repens* proceeding south from the latter locality to the colder parts of New Zealand, and *B. indica* extending northwards into warmer latitudes.

A large area on either side of the drainage channel is in the sole occupation of a maritime sedge, *Carex pumila* Thunb., which prefers a position less constantly inundated than that favoured by *B. indica*, the volume of surface water regulating the boundaries of these two species. The *Carex* is one of the few plants which are capable of existing on the strand, usually choosing the level stretches at either end of the beach under the lee of the headland, and spreading thence to the dune when the conditions are favourable. It is distributed along the coastal beaches by means of its fruit (utricle), a corky watertight vessel which is produced in large quantities. They are swept off by the high tides which occasionally inundate the colony, and carried by the ocean currents to distant beaches, the buoyant water resistant utricle maintaining the flotation, and protecting the enclosed seed. A safeguard against tidal invasion is furnished by the subterranean connective arrangement, the tufted leafy members of the colony rising at more or less distant intervals from the stout ropy

rhizomes, which root below each tuft, simulating underground, the action of the Spinifex on the surface. Behind the Carex a colony of *Scirpus nodosus* is in possession of the dune slope, its scattered clumps penetrating the fringe of a forest of *Banksia integrifolia.*

The Banksia continues the sequence as a pure culture, inland to the Pittwater road, where its association is intruded by a few trees of the "Blood-wood," *Eucalyptus corymbosa* Sm. The "Swamp Oak," *Casuarina glauca* Sieb., has here demonstrated its adaptability, by ascending the dry sandy hill to a considerable distance from its normal habitat on the margin of the lagoon.

South of the entrance to Deewhy lagoon, an association of *Apium prostratum* Labill., the "Australian Celery," is established among the Spinifex. When growing in close proximity to the strand, this diffuse herb incurves the leaves on its exposed margin, presenting a rounded surface to the wind and spray. On the dune the plants are solitary, but in moist situations in the soil pockets and crevices on the rocky ocean escarpment, they frequently form confluent mats in association with *Lobelia anceps* Thunb., and *Samolus repens* Pers.

The dune vegetation from this point to beyond the centre of the beach is herbaceous, one plant (dwarfed) of *Leptospermum lævigatum*, and a few bushes of *Styphelia Richei* Labill., on the frontal slopes, were the only shrubby growths noted. The latter, a halophilous species which does not travel far inland, displays a partiality for the dune, rarely extending to the rocky escarpment or hillside. Its susceptibility to exposure is invariably expressed by dwarfing (nanism), a considerable degree of shelter being necessary for the attainment of its maximum stature.

The rearward dune slope trending towards the waters of the lagoon is carpeted at its base by a lawn of *Zoysia*

pungens. Nearing the lagoon the latter meets and enters an association of *Carex pumila*, which extends—accompanied by the rapidly weakening Zoysia—to the verge of the muddy zone fringing the lagoon, where the further progress of the Zoysia is arrested, the Carex proceeding alone towards the submerged area. The shallow water bordering the mud is occupied by several semi-aquatic species, grouped in accordance with the degree of submergence suited to their requirements. *Mimulus repens* R.Br., and *Selliera radicans* Cav., remain in the vicinity of the muddy region, *Cotula coronopifolia* L., *Samolus repens* Pers., and *Cotula reptans* Benth., advancing in this order towards the deeper water. Neither *Cotula reptans*, nor *Mimulus repens*, were noted on the rocky headland, but *Selliera radicans*, and *Cotula coronopifolia*, were occasionally observed associated on the drainage soaked ledges of the escarpment.

Near the southern (sheltered) end of the beach, *Scævola suaveolens* R.Br., spreads a heavy succulent carpet, closely investing and retaining the sand within its boundaries. It is almost entirely restricted to the frontal dune slopes, rarely crossing the embankment plateau. The end of the beach is flanked by a bank of shale, which curves towards the rocky headland running south to Deewhy head, trailing stems of *Kennedya rubicunda* and *Mesembryanthemum æquilaterale*, festooning the weathered verge of the shale-bank.

On the rocky headland, a rhizomatic colony of *Dianella revoluta* R.Br., is established in a shallow bed of soil in the rock benches. This species also frequents the dune, but is unable to reach the frontal slopes, and is usually found in the open country at the rear among the hardy undergrowth. Its fibrous framework does not make a heavy demand upon either food or water supply. A considerable percentage of

the vegetation on the ocean headland consists of the prickly narrow-leaved *Melaleuca nodosa* Sm., a species edaphically adaptable but climatically restricted. It is present on the landward sand hills and on the Wianamatta shales of the Bankstown-Cabramatta district, retaining its xerophytic leaf structure in both regions. In the latter area it occasionally covers large tracts several acres in extent, with a practically pure culture.

On the exposed (southern) slope of Deewhy Head the vegetation is low and closely packed, creeping over, or clinging to the verges of the boulders and benches, and rooting in the soil pockets among the rock masses. The wiry leaved *Xerotes glauca* R. Br., forms ribbon-like colonies in the soil trenches, curving among the rock benches, or takes exclusive possession of a shallow basin. Plants of the flat-stemmed (cladode) *Bossiœa scolopendria* Sm., growing in the rock crevices have developed exceptionally large tufts which demonstrate the suitability of this species for a harsh exposed position, The trailing stems of the "Sarsaparilla," *Smilax glycyphylla* Sm., wind in and out among the low shrubs or coil themselves upon each other on the bare rock ledges. *Marsdenia suaveolens* R. Br., a twiner under favourable conditions, can only maintain, in this situation, a short debilitated stem, with rarely a few branches.

A few spreading tufts of the somewhat rare *Schœnus tenuissima* Benth., find a lodgment in the soil pockets, but it is better suited in sandy peaty soil, which, though constantly moist, is rarely inundated. Its ascertained range northwards does not extend far beyond Port Jackson, and it was until recently regarded as an exclusively coastal species.[1] Several plants of the scrambling *Bauera rubioides* Andr., which is usually found on the banks of a watercourse

[1] Proc. Linn. Soc. N.S.W., xxxv, p. 412.

are established among the boulders. The drastic change in the conditions on the headland has compelled the plants to reduce their bulk, diminish and toughen their foliage, and encourage a twiggy growth in their branches.

In a sheltered hollow in which a swampy seepage has collected, a patch of *Bæckea crenulata* R. Br., is established. This shrub presents a considerable divergence in habit and height of the plants, and in size and arrangement of the leaves, within its coastal boundaries. In his description of the species, Bentham (Fl. Austr., iii, 78), allows a margin in the length of the leaves from $1\frac{1}{2}$ to 3 lines. The plants on Deewhy Head average 18 inches in height, with leaves 2 lines long. This form is also found in swampy places in the Centennial Park, and extends viâ Hornsby to the Blue Mountains, in similar situations.

On the exposed frontal ledges of the parapet above the ocean escarpment, this small leaved form is prostrate and matted, but gradually assumes an erect habit as it retreats from the verge. In the soil pockets on the broken cliffs of the ocean escarpment at Manly, Bondi, etc., a form occurs with symmetrically decussate leaves $4\frac{1}{2}$ lines long, which reaches a height of 3 feet. Growing side by side with this form, plants of a similar height were noted, whose leaves were slightly smaller, more distant. and not strickly decussate. A closer scrutiny revealed the two forms as young and old plants, the former with succulent, closely packed leaves, regularly arranged in opposite pairs, and the latter with shrunken leaves, a sufficient number of which had fallen, to obscure the decussate alternation, and completely alter the facies of the shrub. Both forms are depicted in Illustr. Cook's Voyage, ii, tt. 103-104, the former, a twig from a young plant, representing the typical species, and the latter, a twig from an old shrub, the var. *tenella* of Bentham. Both forms of the taller, large leaved shrubs—

old and young—occupied positions with free drainage, the smaller plants with lesser leaves, all growing under swampy (xerophytic) conditions.

The stout ropy stems of the parasitic *Cassytha melantha* R. Br., twine round and attach suckers to any vegetation within their reach. The habitat of this species is given in the Fl. Tasm. i, 317, as "Abundant near Launceston growing principally on Acacias." In the Fl. Austr. v, 311, its habitat in W.A. is given as "South West Bay, on Acacias near the sea." It was not noted to exhibit a preference for any member of this genus as a host in the Port Jackson district.

Two Banksias, *B. ericifolia* L., and *B. marginata* Cav., approach to within a few yards of the shoreline. The former does not attain more than a shrubby growth on the rocky headland, a moist peaty soil in a sheltered position being essential for its arboreal development. *B. marginata* is better adapted to this harsh environment, and in favoured positions makes a passable shrub, but its maximum growth is reached on the landward sandhills. *B. ericifolia* is restricted to the coastal districts of south-eastern Australia, its congener, which extends to Tasmania, having a much wider range.

A floriferous undershrub, *Eriostemon buxifolius* Sm., is sparsely represented on the headland. It extends coastally from Gosford to Conjola, but it is most abundant between South Head and Port Hacking, the rocky terraces in the vicinity of the ocean escarpment—it is not found on the dune—accommodating the major portion of its membership. At Waterfall, where it reaches its greatest distance from the coast, and at French's Forest, inland from Manly, the leaves lose their apical roundness and are produced into a lanceolate point. Within the area extending north and south from Manly to George's River, and onwards, as far

at least as the Woronora at Heathcote, *E. buxifolius* is replaced inland by its narrower leaved congener, *E. scaber* Paxt. The latter reaches Liverpool viâ George's River, spreading west towards the Nepean, and extending to the foothills of the southern highlands and the Blue Mountains, whose ascent it is unable to accomplish. The geographical sequence is continued by the varifoliate *E. hispidulus* Paxt., and maintained on the southern highlands to an altitude of approximately 2,000 feet at Hilltop, and on the Blue Mountains to Lawson, 2,400 feet.

From the boundary of this species, westwards to the highest elevation on the Blue Mountains, the sub-alpine *E. obovalis* A. Cunn., represents this closely allied group, whose limits, though not strictly defined, are sufficiently well marked ecological regions, viz., the exposed shoreline; the sheltered equable basin between the coast and foothills; the comparatively mild conditions obtaining on the lower slopes of the Blue Mountains; and the bleak, storm-swept, sub-alpine area. Notes appended to the descriptions of these Eriostemons by Bentham,[1] disclose a difference of opinion between the author and Baron von Mueller, on the relative specific values of *E. hispidulus* Sieb., and *E. scaber* Paxt. Bentham also suggests that *E. buxifolius* Sm., is merged into *E. obovalis* A. Cunn.

These four forms are differentiated chiefly on foliar characters, and may well be considered as species in the making, the variation shown in a series of examples of *E. hispidulus*, exhibited before the Linnean Society,[2] showing a degree of divergence equal to that which distinguishes any member of the group from its allies. The following five species are found on the rocky hillside rising from the headland, and are endemic in New South Wales. *Grevillea*

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[1] Fl. Austr. i, pp. 333, 334.

[2] Proc. Linn. Soc. N.S. Wales, p. 415, 1915.

punicea R. Br., is limited to the coast, extending from the Hawkesbury River to Port Hacking. *Hemigenia purpurea* R. Br. is found as far south as Dapto, and has ascended the Blue Mountains to Linden. The divaricately branched *Podocarpus spinulosa* R. Br., which extends south to Conjola, has followed the course of George's River to Liverpool, and ascended the southern highlands to Picton. The rigid, exposure resistant, "Honey Flower," *Lambertia formosa* Sm., has a lengthy coastal range, and surmounts the western slopes of the dividing range at New England, the Blue Mountains, and the southern highlands. *Pultenœa elliptica* Sm., ranges coastally from Bermagui to Morrisset and reaches Barber's Creek on the southern highlands, and Leura on the Blue Mountains.

A further series of species (five) which occur on the hillside and are found in New South Wales and Queensland only are as follows:—*Actinotus Helianthi* Labill., the "Flannel Flower." The plants of this popular favorite, though usually scattered, occasionally form compact associations. The close colonisation of an area by this species is reminiscent of the apparently spontaneous occurrence in a district of certain well known aliens, which flourish luxuriantly for a period, after which the plants lose their vigour, and the colony disintegrates, or in some instances entirely disappears. Its congener *A. minor* DC., a prostrate herb, does not depart from its solitary habit. On the headland *Phyllota phylicoides* Benth., is dwarfed, its woody rootstock spreading laterally and sending up numerous short twiggy stems. In the sheltered gullies on the lower slopes on the Blue Mountains it assumes an erect habit, and softens the asperity of its foliage. *Olax stricta* R. Br., a graceful shrub with an open, distichously arranged, branching habit, and the heath-leaved *Philotheca australis* Rudge, whose range extends far into the interior, completes this group.

Two species which range from Queensland to Victoria are the spreading, flexible stemmed *Scævola hispida* Cav. and the very common—in the Port Jackson district—*Dodonæa triquetra* Wendl., the latter responding very quickly to exposure by reducing the size of its leaves. The typical *Xanthosia pilosa* Rudge, with a heavy grey vestiture on the underside of its leaves, frequents the rocky hillside, the form with a brown foliar tomentum remaining further inland. Two Acacias are occasional on the headland, the pinnate-leaved *A. discolor* Willd., and the "Coast Golden Wattle," *A. longifolia* Willd. The latter is more frequent on the dune where it is prominent on the frontal slopes, but *A. discolor* favours the rocky hillside, and though occasional on the inland sandhills does not closely approach the beach on the dune.

The headland at its southern end descends abruptly to the strand with a bank of sand at its base sloping to the entrance of Manly Lagoon. Much of the hillside vegetation is continued on the sand-bank, the "Coast Rosemary," creeping along its crest some 300 yards inland. At the base of the slope on the banks of the lagoon entrance channel, a semi-aquatic creeper introduced from America, *Hydrocotyle umbellata* L., var. *bonariensis* Spreng., forms an underground network of stems, and carpets the surface with its large orbicular peltate leaves, which lie closely appressed to the sand on the moist verge of the channel, or are raised on their long petioles when growing in a lawn of Zoysia on the dune slope. Though it flourishes best near the water, it will creep up a dry steep sandy embankment to a considerable height. This alien was first discovered by the writer in 1902, on Freshwater Beach.[1] Its range as now known extends northerly to Newcastle, and as far south as Thirroul where it was recently collected by

[1] Proc Linn. Soc. N.S. Wales, xxiii, p. 906.

Mr. A. H. S. Lucas. It was also noted some distance inland at Gosford State Nursery in a swampy patch, creeping among the rank undergrowth. In this situation the rhachis of the inflorescence, in common with the leaf-stalks, has elongated in response to the influence of shade and moisture.

On the southern side of the lagoon entrance the dune embankment rises abruptly to a height of 25 – 30 feet. On the plateau at the northern end is a shallow depression, the remnant of the usual valley, which has been levelled for the greater part of its length by the deposit from a huge wind-torn rent in the embankment further south. This hollow harbours a shrubby vegetation, among which *Myoporum insulare* R. Br., a floriferous, halophytic plant with succulent fruits, occupies a prominent position. This species, which is closely confined to the coast, is replaced a short distance inland at Brighton-le-Sands by its arboreal congener, *M. tenuifolium* Forst. var. *acuminatum* Benth. *Elæodendron australe* Vent., also found in the depression favours the coastal brush, and is only occasional on the dune.

Southwards the embankment is disrupted to its base, the cavity extending 100 – 200 yards along the front and a similar distance inland. On the floor of this gap *Festuca littoralis* is in undisputed possession. Its colony, originating on the southern side of the breach under the lee of the broken embankment, has spread over the greater part of the denuded area, its tufts plentifully sprinkled upon the bare territory into which no other species has yet ventured, and working seawards to a point well below high water mark. The Fescue has already raised a low uneven bank in the centre of the excavation by the previously explained process. The displaced sand deposited on the rearward slopes has buried the smaller shrubs and undergrowth, a few trees of *Banksia integrifolia*, and *Casuarina glauca*,

alone surviving. On the newly formed bank the Fescue has erected an irregular system of elongated bands running parallel to the beach, stretching ribbon-like, along the otherwise bare sand and creating a series of ridges, whose confluence, when consummated, will form the nucleus of the landward embankment of the dune valley which will eventually be developed. In this region also the Fescue is unsupported, no other species with the qualification necessary for existence in this unstable environment having yet appeared, but its associate the Spinifex, is moving out from the embankment plateau to connect with the Fescue, and assist by retaining the bank which the latter is building.

At the southern boundary of the excavation, a second similar breach occurs. On the frontal slope of the embankment, south of these gaps, which here enters the protected zone under the influence of the shelter provided by the northern headland of Freshwater Beach, the succulent trailer *Senecio spathulatus* A. Rich., has formed a chain of mats several hundred yards in length, on horizontal ridges at a relatively even elevation above the strand. This species has been collected as far north as Port Stephens, but is more securely established south of Port Jackson, and rarely leaves the vicinity of the strand. It responds quickly to a halophilous environment, modifying its leaf structure chiefly in the direction of diminished length, and increased rotundity and thickness, as the soil salinity is increased.

A considerable area on the rearward slopes is occupied by a dense coppice of the "Coast Tea-tree," in whose darkened precincts a colony of *Podocarpus spinulosa* is established. The *Podocarpus* is an exceptionally rigid species, and does not exhibit a marked difference in either structure or habit when growing in this dense shade, to that maintained on the open hillside subject to direct

isolation. At the southern end of the beach the dune is merged into the headland, a belt of dwarfed plants of *Banksia serrata* L., 3 – 5 feet high, lining its base a few yards above the flood waters of the lagoon. The headland, as it extends seawards, develops the usual escarpment which continues along the ocean front to Freshwater Beach. On its frontal ledges *Selliera radicans*, a species whose proclivities are estuarine rather than littoral, creeps along the surface of the shallow mud in erratic lines, which, in favoured positions, become united into small carpets. The broad succulent leaves which are closely appressed to the ground, act in conjunction with its underground stem and root system, as a protective agency against the displacement of the soft earth by the rock seepage. This species has a climatic range from a few miles north of Port Jackson, south to New Zealand, and is also found in extra-tropical South America.

In a shallow water channel on the hillside, a series of plants, ligneous and herbaceous, find a congenial habitat. Of the shrubs, *Callistemon linearis* DC., has rigid linear leaves, the oldest of which, those at the base of the branches, it discards in response to a diminished water supply. Its frequent associate *Hakea pugioniformis* Cav., does not under similar conditions shed its leaves, but shortens them and arrests the internodal elongation, which results in leaf aggregation and consequent reduction of the isolated surface. Representative herbaceous plants in the water-channel are *Goodenia bellidifolia* Sm., *Velleia lyrata* R.Br., and *Stypandra umbellata* R.Br., all of which have rosulate leaves, flattened on the ground when the surface is flooded and the foothold insecure, relaxed and uplifted as the surface dries and a measure of stability is restored. The first named has a considerable coastal range, and ascends the eastern slopes of the dividing range to the tableland in

several places. *Velleia lyrata* is more restricted, occurring most frequently in the Port Jackson district, though it has been collected as far north as Gosford.

Three shrubs were noted on the headland with xerophytic heath-like foliage, two of which, *Calycothrix tetragona* Labill., and *Kunzea capitata* Reichb., found colonies on the rock benches, the former maintaining the larger and less intruded association. The third, *Styphelia microphylla* Spreng., has a scattered membership among the boulders. A dwarfed form of *Pimelea linifolia* Sm., common and variable—the latter the natural corollary of the former—is occasional on the headland and was also noted on the plateau and rearward slopes of the dune. The fugacious flowered *Patersonia sericea* R.Br., is plentiful, and the slender wiry-stemmed *Cœsia parviflora* R. Br., more scantily represented among the undershrubs, the former arranged in circular clusters in well drained positions on the hillside. The *Patersonia* is represented on the Blue Mountains by its var. *longifolia*, a much smaller plant with narrower leaves, a result of the deleterious conditions obtaining in its selected habitat, a peaty, badly drained soil with a cyperaceous association.

Ruelingia hermanniæfolia Steetz, a low spreading twiggy shrub, descends the hillside to the exposed terrace above the escarpment. For the greater part of the year the plants are plentifully furnished with foliage, but during the fruiting period leaf production is suspended, the plants expending the whole of their energy in the propagation of the capsular fruits, which are borne in great profusion on the upper side of the leaf denuded branches, the dwarfed shrubs presenting an extensive fruit covered surface. A tall neighbour, *Casuarina distyla* Vent., which has permanently reduced its leafage to a minimum, also devotes a considerable effort to the formation of the large woody fruits with which its branches are laden.

Several prostrate divaricately-branched examples of a small undershrub *Micrantheum ericoides* Desf., are scattered on the headland. In its customary habitat on the peaty margin of a swamp it is upright, and there is no ramification of the branches. This species extends from National Park to Queensland, and creeping round on the coastal sandstone has reached and ascended the Blue Mountains to a height of 2,000 feet at Hazelbrook. *Phebalium squamulosum* Vent. is dwarfed when subjected to exposure on the headland, though in sheltered positions it may reach its normal height, 3 – 4 feet. The plants in this station have much broader leaves than those of a form growing in a well favoured position among the alluvial detritus on the banks of the Nepean River at Douglas Park.

The "Native Rose," *Boronia serrulata* Sm., is suspected of parentage in the production of a natural hybrid, *B. serrulata* × *B. floribunda* Sieb.,[1] both of which are found on the headland. The former has a limited range on the coastal sandstone from Gosford to Port Hacking. *Acacia suaveolens* Willd., one of the earliest flowering Wattles, has shorter leaves when growing on the headland than its confreres on the landward sandhills. An orbicular, fleshy leaved form of *Trachymene Billardieri* F.v.M. var. *crassifolia* Benth., occupies a frontal position on the ledges above the escarpment. Of this variety Bentham, (Fl. Austr., iii, 357) says, "...and at first sight it appears to be a well marked species but the differences may possibly be due to a sea-coast station."

A glumaceous association of tufted plants, which intermix freely, is established on the shallow sand patches and soil pockets on the rock benches. Of these, *Lepidosperma viscidum* R. Br., has adopted the xerophytic device denoted by its specific name. On a warm day, when the viscid

[1] Proc. Linn. Soc. N.S. Wales, Vol. XL, p. 419.

exudation is greatly increased, a sticky stain is left if the leaves are drawn through the hand. Its congener *L. concavum* R. Br., has thinner and more flexible leaves and stems. The diœcious *Restio dimorphus* R. Br., a coastal sandstone species common in the Port Jackson district, spreads a drooping plume-like tuft whose density presents an effective barrier to intruders.

Panicum marginatum R. Br., a wiry-stemmed straggler, reduces the density of its tuft under drought conditions by restricting the number of its stems, and narrowing and recurving the margins of its leaves. Discussing the varieties of this species, Bentham, (Fl. Austr., vii, 486) says of *P. strictum* R. Br.—which he has reduced to a var. of *P. marginatum*—"Some specimens seem to show that the *P. strictum* is rather an aftergrowth from plants that have been cut down than a distinct variety." In one of the swamps in the Centennial Park there is a dense growth of this form which under normal conditions has the flattened habit of the typical *P. marginatum*, but after a fire has run through the swamp the young shoots are upright and luxuriant, exhibiting a striking contrast to the older growths which have escaped the fire. The swamp form is more compact than the rock-dweller, and does not attain either the elongated paniculate inflorescence or the breadth of leaf of the typical *P. marginatum.*

Descending from the headland to Freshwater Beach, *Rottbœllia compressa* L.f., a climatically adaptable species which has reached Australia from India viâ the Malayan Archipelago and proceeded south to Tasmania, was noted lining the moist rock benches at the base of the escarpment, flanked by small communities of *Lobelia anceps* and *Samolus repens*. The association under similar conditions of this series of swamp habitues was frequently observed. The vegetation on the dune at Freshwater Beach has been

extensively deleted, the remainder presenting no exceptional features. This applies also to the headland at the south end of the beach on which the flora is similar to that described on the northern headland.

On the rugged escarpment at the northern end of Manly Beach numerous plants of *Olearia dentata* Andr., find a lodgment. The normal habit and stature of these soft-wooded shrubs is well maintained in this exposed position, but a considerable divergence in foliage was noted, the flowers also varying in colour from deep blue to pure white. The usual comparatively flat area at the end of the beach is covered with an almost pure growth of *Carex pumila*, into which the Spinifex—a few trails of which crown the occasional ridges—is the only intruder. Behind the Carex, which runs inland 200 – 300 yards along the banks of the entrance channel to Curl Curl Lagoon, two introduced shrubs *Polygala myrtifolia* L., a native of South Africa, and *Lantana Camara* L., from South America, have in combination colonised an extensive tract on the banks of the channel.

The dune embankment at Manly Beach has been artificially levelled and turfed, and protected by a wall of masonry extending from the southern end of the beach to some distance beyond the centre. At the northern end the front is unprotected and requires constant renewal, both Couch and Buffalo, of which the lawn is composed, receding as the bank is eroded. The wind is here raising a sand-ridge parallel to the turfed embankment—upon which the Spinifex is already established—which will eventually afford a measure of protection to the artificial sward.

Immediately behind the beach an avenue of the Norfolk Island Pine, *Araucaria excelsa* R. Br., has been planted, the results fully justifying the encomiums bestowed upon this tree for maritime situations by the Government

Botanist, Mr. J. H. Maiden, who on p. 984 of the article on "The Sand-drift Problem," previously referred to, says:— ......"It revels in the sea air; its narrow leaves and conical shape present comparatively little resistance to strong winds; it is ornamental in appearance, and it furnishes a useful soft wood."

At the southern end of the beach several trees, the remnant of a forest of *Melaleuca leucadendron* L. var. *albida* (Sieb.) E. Cheel MS. (*Melaleuca Smithii* R.T. Baker) whose usual habitat is low-lying swampy ground, are established on the rocky hillside which runs eastward to the ocean headland. On its sheltered (northern) slope a series of grasses occur, all occupying dry stations. The slender stemmed *Panicum parviflorum* R. Br., Small-flowered Finger-grass; *Echinopogon ovatus* Beauv., the Rough-bearded grass, with a climatic range from Northern Queensland south to New Zealand; the variable *Poa cæspitosa* Forst.; and the weedy, cosmopolitan, Parramatta Grass, *Sporobolus indicus* R. Br. Two Restiaceous plants, *Caustis pentandra* R.Br., and *Lepyrodia scariosa* R. Br., are here occasionally associated. The latter is more frequent in the drier parts of the swamp, the conditions prevailing in either station producing a similar effect on the size and habit of its tufts. The Caustis is confined to the sandstone hillside, and in the open forest country in the National Park, and on the lower slopes of the Blue Mountains is a graceful plant with a drooping habit, its cane-like stems reaching a length of seven feet, but on the headland it is reduced to a stunted tussocky growth rarely exceeding two feet in height.

On the soil patches coating the drainage soaked, basal rock ledges, a typical congeries of ruderal plants is assembled. The mud-creeping Penny-wort, *Hydrocotyle vulgaris* L., overruns the tufts of *Cyperus polystachyus*

Rottb., and sprawls among the lax stems of the Sheep's Sorrel, *Rumex acetosella* L., the latter indicative of a sour soil; and the Bushy Star-wort, *Aster subulatus* Mich., of the North American salt-marshes finds in this environment a satisfactory substitute for its natural habitat. As a result of the bad drainage and lack of æration, the tufts of *Scirpus nodosus* located in the muddy area have become debilitated, and the weakened stems unable to maintain their normal erect habit are relaxed and prostrate.

Two Rutaceous undershrubs, *Zieria lævigata* Sm., and *Eriostemon Crowei* F.v.M., are well represented on the sandstone hillside, to which they are edaphically restricted. Both species extend from Victoria to Queensland, and ascend the eastern slopes of the dividing range to the table-land. The Blue Mountain form of *Z. lævigata* was described as a distinct species under *Z. revoluta* by Allan Cunningham, in "Field's New South Wales," p. 330, but was later reduced by Bentham, (Fl. Austr. i, 304) to a synonym of the former species. The Dwarf Apple, *Angophora cordifolia* Cav., a local species found on the coastal sandstone from Woy Woy to National Park, forms small exclusive colonies.

Two forms of the Geebung, *Persoonia lanceolata* Andr., differing chiefly in size of leaf, occur on the hillside, both maintaining their distinct leafage on the landward sand-hills. *Ricinocarpus pinifolius* Desf., *Trachymene linearis* Spreng., *Acacia juniperina* Willd., and *Styphelia ericoides* Sm., have all narrowed their leaves with a transpiration reducing objective. *Epacris longiflora* Cav., is very susceptible to the influence of shade, moisture and drainage, plants growing within a few yards of each other quickly responding by enlarging or reducing their foliage as these factors are favourable or the reverse. *Styphelia tubiflora* Sm., a twiggy undershrub, occurs in isolated patches on

the hillside. A widely separated community of this species occurs on the higher slopes of the Blue Mountains.

Two *Hibbertias* were noted, the upright *H. linearis* R.Br. and the straggling *H. fasciculata* R. Br., at a distance from the line of exposure. The weedy *Pomax umbellata* Sol., does not alter its configuration either on the open hillside under direct insolation or in the dense shade of a shrubbery. Its occasional associate, *Chloanthes Stœchadis* R. Br., on the contrary, responds quickly, by reducing the size of its leaves, when subjected to direct sunlight.

Billardieri scandens Sm., on the open hillside is reduced to a shrubby growth. Its climbing habit, though temporarily suspended, is disclosed by the advent of one or more rampant twining shoots in the early spring, which are unable to persist in the absence of shrubs to climb upon. The rigid leaved Burrawang, *Macrozamia spiralis* Miq., is well equipped, both above and below the ground line, to withstand drought conditions, hypogeally, by virtue of its tuberous rootstock—a reservoir of food and moisture—and epigeally by means of its transpiration resistant foliage. The frequent mutilation of its leaves by grazing animals has resulted in a reduction in the length of the frondage.

Two Eucalypts, the Blood-wood, *E. corymbosa*, and *E. virgata* Sieb. var. *obtusiflora* Maiden, form small groves on the hillside, occasionally in close proximity but not intrusive. The former in favourable situations attains the dimensions of a large tree, but in this impoverished soil can only maintain a limited arboreal growth.

On the lower slope of the hill where the shoreline winds into Cabbage-tree Bay, the straggling *Rumex scutatus* L., an immigrant from southern Europe, has established its trailing stems among the Kangaroo-grass and other cæspitose vegetation, its succulent herbage indicating its xerophytic protective device. Though not exclusively con-

fined to a saline environment it is more robust when growing in the vicinity of the sea. This plant is an aggressive coloniser, its trailing stems, thickly covered with heavy leaves, eventually building up a close screen, and depriving the undergrowth within its network of the necessary light. It is assisted underground by its tuberous root system—reminiscent on a larger scale of the Nut Grass, *Cyperus rotundus* L.—which develops into an intricate mass, taking possession of the soil and starving out the existing vegetation. Its relatives, the Curled Dock, *Rumex crispus* L., and *R. pulcher* L., the Fiddle Dock, find a congenial home in the drainage channel at the base of the escarpment. Both species frequent the marsh, or the margin of the water-course, and produce fruits in which the seeds are enclosed in a corky case suitable for water carriage.

On the sheltered banks of Cabbage-tree Bay a limited "brush" association is established. Two Native Grape vines, *Vitis hypoglauca* F.v.M., and *V. Baudiniana* F.v.M., are growing side by side—a frequent occurrence—their branches interlaced. *Pittosporm revolutum* Ait., occupies a more exposed position on the hillside. The three above species range coastally from Queensland to Victoria, and ascend the eastern slopes of the dividing range to the tableland viâ the brush gullies. The Port Jackson Fig, *Ficus rubiginosa* Desf., roots in the sandstone crevices, its trunk spreading over and moulding itself to the contour of the rock ledges. When growing in the rich soil of the brush forest, this basal trunk expansion is produced in the form of flanking buttresses. There is no dune embankment behind the diminutive beach, which is carpeted above high-water mark by *Carex pumila.*

On the strand at the base of the hill a row of Coral-trees, *Erythrina indica* Lam., has been planted. A native of the East Indies which has reached the Northern Territory

viâ the Malayan Archipelago and crept down the Queensland coast, it has not yet spontaneously reached a station south of our northern river system in New South Wales, and probably most of the trees in that district were planted by the settlers. That cooler climatic conditions offer no obstacle to its progress southwards has been amply demonstrated by the success attendant upon its acclimatisation in the southern Illawarra.

In a valley draining into Cabbage-tree Bay, and running parallel to the ocean escarpment, a typical coastal gully flora is encountered. On the banks of the watercourse a solitary example of the purple berried *Eugenia cyanocarpa* F.v.M., was seen heavily loaded with fruit, though but a slender shrub eight feet high. The fruiting of this tree in the juvenile stage is mentioned by Messrs. Maiden and Betche in a note on the species.[1] The Mock Orange *Pittosporum undulatum* Andr., a shapely ornamental tree when growing in the brush forest, is somewhat cramped on this rocky hillside, presenting a straggling appearance and a sparse leafage. The Sydney Black Wattle, *Callicoma serratifolia* Andr., a withy stemmed shrub, the sole representative of a genus endemic in Australia, was noted in its customary position among the boulders in the watercourse.

A halophytic shrub *Glochidion Ferdinandi* J. Muell., which also grows near the watercourse, and frequents the foreshores of the harbour, is extremely sensitive to frost when growing at a distance from tidal waters. This inability to withstand frost when removed from a saline environment is even more pronounced in the soft-wooded *Hibiscus diversifolius* Jacq. Seeds taken from a chaparal of these plants growing close to the water's edge at Botany Bay were propagated at the Centennial Park, and the resultant plants made a sturdy growth, attaining their full

[1] Proc. Linn. Soc. N.S. Wales, Vol. xxix, p. 741.

height within the growing season. The winter frosts wilted their leaves and blackened their stems, eventually destroying them, the plants growing in their natural environment, though unsheltered, escaping uninjured.

Two twiners *Geitonoplesium cymosum* A. Cunn., and *Eustrephus latifolius* R. Br., find in the canopy and support of the tall shrubs and trees suitable conditions for climbing, the two species, their stems intertwined, occasionally mounting the same tree. Their range is similar, neither advancing far inland, and both extending from Queensland to Victoria. Both species are generically monotypic. An individual specimen, the only one noted on the shore line, of a large fruited Eucalypt, overhangs the watercourse. It is considered by the Government Botanist, Mr. J. H. Maiden, to be an intermediate form between *E. pellita* F.v.M., and *E. resinifera* Sm., both of which are exhaustively treated in his "Critical Revision of the Genus Eucalyptus," Vol. III, Part 10.

Pultenœa daphnoides Wendl., a common coastal gully shrub, is occasional among the larger growths near the watercourse. It extends from Port Stephens south to Tasmania, and ascends the Blue Mountains to the eastern slope of King's Tableland. The Christmas Bush, *Ceratopetalum gummiferum* Sm., is also occasional in this shady situation, but its greater frequency on the open hillside marks its preference for the latter situation. The foliage of this species is an excellent phenological indicator, the leaves responding in a marked degree to seasonal changes. It is confined to New South Wales, is chiefly coastal, and ascends the Blue Mountains to Katoomba.

The dimorphic leaved *Rapanea variabilis* Mez, has prickly margined juvenile leaves, which are not maintained in the adult foliage, a physiological metamorphosis whose function is still in the controversial stage. It is here

associated with the Blue-berry, *Elæocarpus reticulatus* Sm., both species displaying a preference for the shelter of the gully and the proximity of the watercourse. The association is maintained throughout their geographical distribution which is centred in New South Wales, extending northerly into Queensland and southerly to Victoria, both species also reaching a considerable altitude at various points on the dividing range.

Several plants of *Casuarina suberosa*, are scattered along the watercourse intermixed with the larger shrubs. The characters usually relied upon to separate this species from its congener *C. distyla*, are, its erect habit, slender branchlets, and truncated cones. The two first mentioned characters are largely dependent upon ecological conditions. When growing individually, as noted above, the plants of *C. suberosa* have the spreading habit and coarse branchlets of *C. distyla*, but when assembled in a close coppice formation (its usual habit) the growth necessarily becomes erect. In such an assembly growing in a swampy flat in the Centennial Park, the branchlets are typically slender. The truncated cone of *Casuarina suberosa* is not infrequently simulated by that of *C. distyla*.

On the hillside rising from the gully to the ocean escarpment, the open sandstone vegetation includes examples of a broad leaved form of *Hakea dactyloides* Cav.; the indifferently named *Styphelia triflora* Andr.—it is the exception rather than the rule that the flowers are in clusters of three; and the fascicled leaved xerophyte *Darwinia fascicularis* Rudge.

Kunzea corifolia Reichb., which on the shale flats in the Cabramatta-Bankstown district forms associations several acres in extent, is unable on this sandstone hillside to maintain a large colony, and is occasionally represented by a group of two or three plants. Climatically it is a cool

country species, extending from the Port Jackson district south to Tasmania. It ascends the Blue Mountains to Lawson and reaches Hilltop on the southern highlands. The weak, diminutive, *Cryptandra ericifolia* Sm., is occasional in the damp soil pockets, its slender branches in this exposed area prostrate and scantily clad with foliage. In the peaty soil of the swamp,—its customary habit—the branches supported by the crowded cyperaceous growth, assume an erect habit and are more plentifully supplied with leaves.

Numerous tufts of *Restio fastigiatus* R. Br., are scattered among the rock crevices. This species, endemic in New South Wales, was known only from the Blue Mountains and the Port Jackson district, until collected by Mr. R. H. Cambage at West Dapto and Pigeon House, Milton.

Along the verge of the ocean escarpment of the headland running south to Port Jackson, *Gleichenia circinata* Sw., hangs in heavy festoons from the topmost ledges, its creeping rhizomes invading the crevices on the face of the cliff, the tangled masses losing in volume as it descends to the wave splashed region at the base of the escarpment. The New Zealand Spinach, *Tetragonia expansa* Murr., which maintains its xerophytic succulence from the sea-coast to the salt-marshes of the interior, has here developed leaves much larger than those noted in any other station. When growing on an escarpment flanking the beach it occasionally descends to the strand, but cannot proceed far from the base of the cliff. Its presence on the headland is casual, the large area covered by its carpet in the tidal basin or salt-pan, disclosing its partiality for an estuarine station.

In such an environment the heavy fleshy limbs and foliage perform the dual offices of maintaining stability and regulating its water supply. In a note on this species in the Fl. Tasm., Vol. I, p. 148, Sir. J. D. Hooker, says, ..."It

sometimes bears flowers at the top of the horns of the fruits." An example of this unusual form of heterotaxy in the New Zealand Spinach, was exhibited before the Linnean Society by the writer.[1]

Apium prostratum has in this region remodelled its leaf dissection, varying it from the linear segmentation of the lobes of the inland form, to a broad obtuse lobing, an alteration of form noted by Bentham, Fl. Austr. iii, 372, in a reference to the maintenance of two distinct species of this herb, a proposition with which he was not in agreement. The breadth of the lobes is still further accentuated when the plants are growing in the strand sand. Its frequent associates on the escarpment, *Samolus repens*, and *Lobelia anceps*, rarely descend to the beach, and are unable to establish their colonies on the open strand. The latter prefers to creep among the rushes and sedges in a swamp, and in such a situation narrows and elongates both stems and leaves. *Samolus repens* also frequents the swamp but reaches its maximum growth in the estuary, where it frequently lines the low muddy banks with a broad marginal band, occasionally many hundred yards in length, or invades the precincts of a Mangrove forest. The creeping stolons, netted below, and the decumbent stems, matted above, bind the community together, enabling it to ride secure from tidal invasion on the unstable mud.

On the escarpment the Buffalo Grass exhibits a greater exposure resistant capacity than the Common Couch, *(Cynodon)* carpeting the rock ledges for some distance down the face of the cliff, the Couch rarely venturing from its haven on the parapet above. *Zoysia pungens* has again demonstrated its superiority over both its congeners, by descending to the spray-drenched soil pockets at the base of the escarpment.

[1] Proc. Linn. Soc. N. S. Wales, Vol. xxxix, p. 513.

Epacris crassifolia R. Br., a robust form mentioned by Bentham, Fl. Austr. iv, 237, which extends northwards as far as Cowan Bay, shares the lower rock crevices with *Gleichenia circinata*. *Wedelia biflora* here presents its characteristic scrambling habit, forming mats on the horizontal surface of the boulders or overhanging their perpendicular walls. *Rhagodia Billardieri* has on this exposed front developed a rock-clinging habit, and its leaves have lost much of the polished surface of its confreres on the dune, a scaly incrustation, not unusual in the family, replacing the coating of varnish.

On the southern side of Port Jackson the rocky headland extends along the ocean front to Bondi. *Melaleuca armillaris* Sm., here first noted, maintains in some measure its erect habit, and in the region of greatest exposure, on the verge of the escarpment, is less dwarfed and prostrate than its rigidly framed congener *M. nodosa*, its elastic stems bending to the storm-blast, and quickly recovering their upright position when the pressure is removed. Both species range from Queensland southwards, *M. nodosa* ending its southern traverse in the Port Jackson district, and its ally proceeding into Victoria. *M. armillaris* is edaphically restricted to the sandstone, and is unable to accompany *M. nodosa* into the Wianamatta Shale belt. The latter is limited as to elevation, and cannot ascend the southern highlands, where *M. armillaris* is established at Bowral, extending also to the Jenolan Caves.

Another member of the genus, *M. hypericifolia* Sm., which was not seen in the area described, though it has been collected on the northern boundary at Newport, and extends south into Victoria, was considered as essentially a sea coast habitue until discovered in the Valley of the Waters at Wentworth Falls in 1906.[1] It has also reached

[1] Proc. Linn. Soc. N.S. Wales, xxxiii, p. 312.

Mittagong on the southern highlands, where it was recently collected by Mr. W. Greenwood 4, 1916. Both *M. armillaris* and *M. hypericifolia*, appear to be fugitives in these mountain localities. The habitat given by Bentham for the latter species, Fl. Austr. iii, 131, is, "In swampy places, Port Jackson," but it is usually found on well drained sandstone hillsides.

A coastal Needle-bush, *Hakea pubescens* Schrad., which has a limited range within the State and occurs also in Queensland, is represented in the Port Jackson district by a few small colonies which are confined to the sandstone hills. The much commoner *H. sericea* Schrad., its nearest affinity, does not so closely approach the shoreline. *Cryptandra amara* Sm., a twiggy xerophytic undershrub, which ranges from the sea-board to the Western Plains, advances in small, closely packed colonies, to a frontal position on the headland. A few isolated bushes of *Styphelia viridis* Andr., Five Corners, are scattered among the headland shrubbery. This species, which has a range from Port Jackson to Queensland, is better represented on the sandhills.

At the top of a "dyke" which here intrudes the escarpment, a sand patch carpeted by the Common Couch, has weathered, exposing its front, and the capillary roots of the Couch are disclosed, threading a tortuous course through the sand to a depth of three feet and matting on the subsoil, a ferruginous hard-pan, which they are unable to penetrate. In the narrow passage of the dyke the only plants noted were *Scirpus cernuus* Vahl., *Apium prostratum*, *Samolus repens*, and *Lobelia anceps*, which associate in elongated mats on the narrow rock ledges, for mutual protection in this wind-swept cavity.

The wiry stemmed *Hypolœna fastigiata* R. Br., is occasional on the rocky hillside, but the larger tufts and their greater frequency on the sandhills indicate its preferential

habitat. The station given for this species by the authors of the Handbook Fl. N. S. Wales, p. 443, is, ..."in wet sandy places." It is very common on the dry sandhills between Port Jackson and Botany Bay and was not noted in moist situations. The Blood-root, *Hœmodorum planifolium* R. Br., is also more plentiful on the dry sand hills than on the exposed headland. Its rootstock is protected by a highly coloured exudation which is responsible for the vernacular name of the plant. Its bulbous base is deeply embedded in the soil and acts as a reservoir, though the pithy consistence of the stem, and the leathery texture of the leaves, obviate the necessity for insistent demands on the supplies conserved.

Its congener *H. teretifolium* R. Br. does not so closely approach the shoreline, and has less objection to a swampy environment. The two species occasionally meet and intermingle on the verge of a swamp, *H. planifolius* ascending the hillside, and its ally proceeding into the swamp. Both are found as far south as Bateman's Bay, *H. teretifolium* extends northerly to Byron Bay, and its congener continues into Queensland. *H. planifolium* is plentifully distributed, but its associate has only a sparse representation in widely separated localities.

The headland at Ben Buckler curves inland, descending in a long slope to Bondi Beach. At the western end of the beach a few tufts of the Marram Grass, *Ammophila arundinacea* Host., were noted among the Spinifex, the sole survivors of a large area planted with this introduced grass. Owing to a combination of adverse circumstances, this valuable sand-binder, with whose aid a large acreage of dune has been reclaimed in Victoria, at Port Fairy and elsewhere, vide "The Sand-drift Problem in New South Wales," *loc. cit.*, has not been successfully established in this district.

An instance of the difficulties attendant upon the establishment of vegetation on the dune at Bondi, came within the experience of the writer. In August 1903, I supervised the planting of a number of shrubs and trees, chiefly Lupines and maritime Pines, which had been grown for this purpose at the Centennial Park, under the direction of the Officer in Charge, Mr. J. H. Maiden. A few days after the work was finished, an exceptionally severe storm arose, and the whole of the plants were buried under two feet of sand in as many days, though defended by three distinct lines of break-winds.

At the eastern end of the beach, partly sheltered by the headland, the Sea Rocket, *Cakile maritima* Scop., ventures across the strand to the verge of the tidal zone, frequently establishing its members among the débris thrown up by the surf. It is a decumbent succulent herb and in this situation is occasionally subjected to a considerable degree of spiral torsion. A strong wind will overturn or twist the plant laterally, the heavy trailing limbs upon which it depends for anchorage, as its root system is neither deep nor ramifying, imposing a severe strain on the stem, which is frequently found curved into one or more complete spirals. The quaint fruits, which consist of two bead-like angular articles, are produced in great profusion, and are well equipped to withstand the buffeting likely to be encountered on a voyage along the coast, which may result in its establishment in a new region, both in regard to the tough buoyant material of which the capsules are composed, and the method of construction, *i.e.*, strongly ribbed and pointed at both ends. This species, which is found in maritime stations in Europe and North America, is recorded among the indigenous flora of this State by the authors of the Handbook Fl. of New South Wales, p. 27, but is not included by Bentham in the Fl. Austr.

The first Australasian record which I can find of this species occurs in "Contributions to the Phytography of Tasmania," by Baron von Mueller.[1] The author, p. 30, says, ..."It is remarkable that this conspicuous and singular plant should have been overlooked so long in Tasmania, where, from my own personal enquiry among the local coast residents it seems to be indigenous, but it was not before 1861 that the *Cakile*, became by my own investigations, discovered on the coast of the Australian mainland." It is plentiful on all the beaches in Botany Bay, and if it had been present (indigenous), at the time of the landing of Captain Cook at Kurnell, it would hardly have escaped the vigilance of the botanical members of the expedition.

A portion of the dune has been treated with ashes and débris, and planted with common Couch, resulting in the establishment of a lawn of several acres, which extends to the verge of the strand embankment, here 3 – 4 feet high, where it is protected by a band of *Zoysia pungens*. The latter species occurs in the maritime sands of tropical Eastern Asia and New Zealand. According to Cheesman[2] it ascends to 2,000 feet at Lake Taupo, and in Canterbury and Otago.

Several exotic weeds are established in the Couch lawn, prominent among which is the aggressive Cape-weed, *Crytostemma calendulaceum* R. Br. At a distance from the strand the root system of this Composite is shallow, its heavy rosette of basal leaves sufficing for the maintenance of equilibrium and incidentally retaining the sand in its vicinity. As the strand is approached, the harsher conditions are indicated by the decreased luxuriance of the foliage, the root system also responding by descending to a greater depth. Several alien *Chenopods* thickly coated

[1] Proc. Roy. Soc. Tas., 1876, p. 29. [2] Manual Fl. N.Z., p. 884.

with a saline incrustation, were noted in close proximity to the strand, among which *Atriplex patulum* L., a typical estuarine species, was liberally represented.

At the rear of the dune in the sheltered valley running in a north-easterly direction, a number of large umbrageous trees of *Melaleuca leucadendron* L. var. *albida* (Sieb.) E. Cheel MS. (*Melaleuca Smithii* R. T. Baker), survivors of the extensive forest of these plants originally in possession of the peaty flat stretching across to Rose Bay, are still preserved in paddocks and private gardens.

On the headland south of Bondi Beach the few flowered *Cladium junceum* R. Br. is established in a swampy basin. *Isopogon anethifolius* R. Br. and *I. anemonifolius* R. Br., both of which are plentiful on the Botany sandhills, are here sparsely represented. An anomalous fruited Composite, *Osteospermum moniliferum* L., an alien from South Africa, where it is a coast dweller, is strongly entrenched on the headland. Originally a garden escape in the neighbourhood of Bellevue Hill, it has spread seawards through the scrub to its natural habitat on the coast.

Two terete leaved members of the genus *Lepidosperma* occur on the headland, *L. flexuosum* R. Br., with large spreading tufts occupying the drier soil pockets, and *L. Neesii* Kunth., with a scanty erect tuft choosing a peaty soil not frequently inundated. The former is restricted on the sea-board to the Port Jackson district, but is sparsely represented on the higher elevations of the Blue Mountains. *L. Neesii*, whose northern boundary is also in the neighbourhood of Port Jackson, extends into Victoria.

On a sandy slope on the northern boundary of the Waverley Cemetery, a favourite garden plant, *Alyssum maritimum* Laon., (an escape from the cemetery) has shown its appreciation of the similarity in the edaphic and climatic conditions, to those obtaining in its native habitat on the

Eastern Mediterranean littoral, by spreading, weed-like, over the sandhill.

On the headland running south to Coogee Bay, the flat rock benches, lightly covered with drift sand, support a dwarfed herbage. *Plantago coronopus* L. spreads a rosette of leaves to shade its shallow roots, retain moisture and secure a foothold. It is a doubtful member of our indigenous flora, and was first recorded for New South Wales from this locality by Mr. Fred. Turner.[1] Among the Plantago, numerous varicolored patches of the diminutive *Polycarpon tetraphyllum* Lœfl. are scattered, the association of these two plants frequently occurring throughout their world-wide distribution.

Two cæspitose herbs *Cyperus tenellus* L., and *Juncus bufonius* L., each with an extra Australian range, form isolated mats on the moist ledges. Though the latter (an annual) is capable of adaptation to a varied habitat, in respect of moisture and drainage, it is unable to maintain its isolation when brought into competition with other herbage in stations with superior drainage, its luxuriance also diminishing with a reduced water supply.

Two spiny fruited weeds were noted in the couch lawn on the dune at the northern end of Coogee Bay, *Soliva sessilis* Ruiz and Pav., and *Emex australis* Steinh. The former, a native of South America, was noted in the Proc. Linn. Soc. N.S.W., xxiv, p. 646, by Messrs. Maiden and Betche, as naturalised in Moore Park, from which it has spread, chiefly in grassland, for a considerable distance along the coast. In a footnote to *Emex australis*, Bentham, (Fl. Austr. v, 263), says:—"A common maritime plant in South Africa differing slightly from the Mediterranean species (*E. spinosa* Campd.) etc." Wright, in Polygonacæ, incorporated in the Fl. Capensis, v, (1911) 481, also upholds

[1] Proc. Linn. Soc. N. S. Wales, xxvi, p. 592.

the South African and Australian forms as a distinct species. Muschler, Man. Fl. Egypt i, (1912) 257, says:—"A small genus of only one species distributed throughout the Mediterranean region, South Africa and Australia. Muschler's species is *E. spinosa* (L.) Campd., and no reference is made to Steinheil's *E. australis*.

On the headland south of Coogee Bay, several members of the typical Port Jackson swamp vegetation are established in a drainage basin. In the centre of the submerged area the stoutly buttressed "tussocks" of *Gahnia psittacorum* Labill., the largest of our Sedges, offers a firm resistance to the pressure of the floodwater, protecting the weaker rooting herbage from its onrush and consolidating the unstable soil. It is assisted in this work by several shrubs, among which the pendulous branched *Viminaria denudata* Sm., is prominent. In the Botany swamps the Viminaria frequently forms large shrubberies which are occasionally devastated by fire. The young growth, which arises in great profusion, is plentifully furnished with broadly ovate leaves, but this juvenile foliage is not long maintained, the xerophytic conditions obtaining in the swamp necessitating the relinquishment of the flattened leaf lamina and the modification of its structure to the elongated cylindrical petiole (phyllode) of the adult plant, which occasionally reaches a length of nine inches.

Dillwynia floribunda Sm., is neither so plentiful nor communal as its larger neighbour and is less partial to the aquatic zone. Its heathlike leaves are erect, the inner whorl closely appressed to the stem and branches, and the outer series imbricately arranged, their close investment affording a measure of protection against adverse xerophytic influences. *Leptospermum arachnoideum* Sm. a low prickly shrub with a divaricately branched habit, and a thicket like growth, also favours a position somewhat removed from the permanently submerged area.

In the peaty soil on the edge of the basin, a slender stemmed trailer, *Oxylobium cordifolium* Andr., has spread an intricately woven canopy over the cyperaceous growth, extending in a narrow ribbon-like formation for a considerable distance along the margin. At Little Bay, individual plants of this species are plentiful in the shallow soil trenches on the rocky hillside, but the environment is unfavourable to luxuriant growth, and the plants rarely cover an area greater than one to two feet in diameter. It is endemic in New South Wales, and has an ascertained coastal range from the southern side of Port Jackson to Milton.

Three Ferns, each with a wide extra Australian range, have formed small exclusive colonies in the partly submerged area. Of these, *Gleichenia dicarpa* R. Br., has bound its members by knitting their wiry stemmed fronds into a tangled network above, and connecting them by creeping rhizomes below the ground line. The rhizomes of this fern are exceptionally sensitive to injury and rarely survive disruption. A similar connecting device is adopted in a modified form by *Histiopteris incisa* (Thunb.) J. Sm., which does not resent removal to the same extent as the Gleichenia. The third member of the group, *Blechnum serrulatum* Rich., has an erect habit, the fronds rising from a short, truncate, horizontal rhizome in plume-like tufts.

Of the smaller growths in the basin the weak stemmed *Boronia parviflora* Sm., straggles among the Sedges, the plants, usually solitary, ranging between the flooded area and the margin, and rarely venturing beyond the peaty soil of the bog. Its frequent associate, the rosetted *Goodenia stelligera* R. Br., is almost as strictly limited in its choice of habitat, and the slender *Schœnus apogon* Roem. and Schult., their occasional neighbour, may be placed in the same category. In this station *Schœnus brevifolius* R. Br.,

has arranged its colony in massed formation. When growing in the sandhill shrubbery, where the foothold is sufficiently stable to obviate the necessity for a protective alliance, its tufts are smaller and disconnected.

Drosera binata Labill., is confined to the submerged area where in the running water, its members are collected into small clusters for mutual support, the plants growing in the slack water on either side of the current retaining their individuality. *Selaginella uliginosa* Spring., which in the Botany district covers large tracts of the drier parts of the swamps, and the sandy slopes on their margins, with a close velvety carpet, is here represented by a few small mats in the peaty soil on the margin.

Proceeding along the headland towards Maroubra Bay, two diffuse undershrubs *Trachymene ericoides* Sieb., and *Styphelia pinifolia* Spreng., and a third, *Styphelia virgata* Labill., with a more erect habit, are occasional in the shallow soil patches. The Native Fuchsia, *Correa speciosa* Andr., avoids an isolated exposed position, usually remaining at a distance from the escarpment in the shelter of the open shrubbery, which provides a wind-break without unduly hampering its movements or screening it from the light. With the exception of Correa, all the genera in New South Wales of the family Rutaceæ, are classed under Choripetalæ, and this genus is divided, *C. alba*, the shore-line representative, with free petals, conforming to the general floral arrangement, and *C. speciosa*, supported by two congeners, adopting an adherent-petalled, tubular corolla.

Numerous scanty-tufted plants of the Plume-grass, *Dichelachne crinita* Hook. f., maintain an erect habit in exposed positions on the hillside, the tall stems bending before the storm, but resuming their upright attitude when its force is expended. In a diminutive drainage soak within

a few yards of the verge of the ocean escarpment, a small colony of the Reed Mace, *Typha angustifolia* L., is established. The customary habitat of these plants is a sheltered lagoon, or the shallow water of a creek, but no diminution of vigour was apparent as a result of this change of environment.

At Mistral Point a sward of Buffalo-grass stretches across the hillside to the escarpment parapet. Its margin is fringed by a dwarfed succulent form of the variable *Senecio lautus* Sol., with short cylindrical leaves. In a swampy drainage channel *Dampiera stricta* R. Br., finds the peaty soil favourable for development, and broadens its leaf lamina. On the dry sandhills its leaves are reduced to a narrow linear blade. Two closely allied species of *Callistemon* have drawn a distinct line of demarcation in their boundaries, indicating their respective attitude towards a swamp environment. *C. linearis* DC., is restricted to the margin of the swamp and can only maintain a narrow elongated leaf, its confrere *C. lanceolatus* DC., proceeding into the centre of the area and supporting a broad leaf-blade.

Eriostemon lanceolatus Gaertn., on the sandhills maintains an ample foliage, which in the plants growing on the sea-board is considerably reduced. The xerophytic *Epacris microphylla* R. Br., finds the crown of a dry sandstone hill as suitable a habitat as one well within the confines of a swamp, and presents a similar facies in either situation.

Three species of the genus Poranthera are present on the headland, *P. corymbosa* Brongn., and *P. ericifolia* Rudge, choosing dry exposed positions, their relative, the prostrate flaccid-leaved *P. microphylla* Brongn., creeping under the rock ledges, or into the denser parts of the shrubbery, in search of shade and moisture. *P. ericifolia*, endemic in New South Wales, has a coastal range from Newcastle to the southern Illawarra, *P. corymbosa*, with

a similar northerly boundary, extends to Victoria, and *P. microphylla* is found in all the Australian States.

Two Cyperaceous plants with a limited distribution, *Tricostularia pauciflora* Benth., low and spreading, and *Cyathochœte diandra* Nees., a tall graceful herb, each with a small representation, and numerous tufts of the Tall Oat-grass, *Anisopogon avenaceus* R. Br., are scattered among the frontal rock benches and ascend the hillside.

In a small swampy basin an association of aquatic herbs is located. The succulent Spurrey, *Spergularia rubra* Camb., which covers large tracts of the tide-flooded marshes at Cook's River, and the close-carpeted mud-creeper *Hydrocotyle asiatica* L., occupy positions on its margin. The tufted, slender, *Triglochin striata* Ruiz and Pav., ventures into deeper water, and its more robust congener *T. procera* R. Br., finds in the centre of the basin a habitat suited to its requirements. The three first named occupants of the basin are cosmopolitan, but *T. procera* is confined to Australia. A coastal form of the polymorphous *Plantago varia* R. Br., with succulent leaves and enlarged rootstock, frequents the crevices on the escarpment flanking the northern end of the beach at Maroubra Bay.

On the strand below, an exclusive colony of the semi-aquatic *Cotula coronopifolia* L., occupies a level tract near the drainage channel. Several isolated plants of the Variegated Thistle, *Silybum marianum* Gaertn., are the sole occupants of a wind-swept flat behind the dune embankment, their long stout taproots, bared in extreme cases a foot deep, supplying sufficient nourishment and support to enable them to persist until the drift again sets in their direction. The frontal slope of the embankment is dominated by the Spinifex, which spreads over the ridges and into the wind-blown channels, consolidating the long stretch of uneven slope between the crest of the embankment and the strand.

On this slope a number of Norfolk Island Pines have been planted, the lowermost row on the strand at its base, all of which are in a flourishing condition.

On the broken verge of the bank the usually solitary plants of *Euphorbia Sparmanni* have, in several instances, become confluent and cap the crown of a knoll or the crest of a ridge. In a shallow depression *Scævola suaveolens* has massed a carpet measuring 18 × 24 feet. The succulent stemmed *Plectranthus parviflorus* Henck., frequently an epiphyte on mossy rock benches or Fern and Orchid strewn boulders in the deep shade of the forest, is exceptionally robust on the exposed dune plateau where the sunlight is unbroken. It also makes a sturdy growth in the soil pockets on the ocean escarpment, displaying in a marked degree its appreciation of this halophilous environment, though it includes the dual disabilities of exposure and extreme insolation.

On the southern end of the beach, in the shallow sluggish seepage flowing across the strand from the swamp at the rear of the dune, a colony of *Carex pumila* has been invaded by the introduced *Hydrocotyle umbellata* var. *bonariensis.* On the strand the Carex is dominant, but as the channel narrows and deepens and its salinity decreases on its inland course, the Hydrocotyle assumes supremacy, closing up its ranks and lengthening the stalks of its umbrella-like leaves, holding the blade aloft in a horizontal position. This formation presents such a complete barrier to the entrance of light, that competition from the surrounding aquatic herbage is effectively suppressed. A plant of *Kennedya rubicunda* has ventured into the swamp, displaying exceptional plasticity in an entirely novel habitat. Though its root system and the lower portion of its stem is submerged, the emerged stem and branches have produced a robust growth. which festoons a considerable area of a shrubbery of *Viminaria denudata.*

On the strand a few small tufts of *Festuca littoralis* are sprinkled, and immediately below the embankment a large hummock 4×3 yards, has been raised and completely clothed by this grass. On the sandy bank which curves towards the headland south of the beach, an alien from South Africa, *Tetragonia nigrescens* E. et Z. var. *maritima* Sond., is established a few feet above high-water mark.[1] It is a maritime member of the Fam. Aizoaceæ, and has the heavy succulent limbs and foliage, and the low spreading growth characteristic of the family, most of whose members are residents of the beach, estuary, or salt-marsh, and include the well known New Zealand Spinach. The wings of the fruit calyx are composed of a felt-like material, eminently fitted to act as a lifebuoy to the capsule, and protect it from injury consequent on violent impact with a reef or other solid obstruction, against which it is liable to be flung by the waves when journeying along the sea-board. The new comer will be a welcome addition to the dune flora in the capacity of a sandbinder.

On the headland running south to Long Bay, the shrubby *Notelæa longifolia* Vent., which in suitable situations reaches a height of ten to twelve feet, is barely two feet high, and has exceptionally large leaves. Several grasses are dotted on the hillside. The robust *Stipa semibarbata* R. Br., its elongated plume-like panicle nodding with the weight of the grain surmounted by a heavy awn; *Danthonia penicillata* F.v.M., a widely diffused and variable species, both edaphically and climatically adaptable; and *Panicum bicolor* R. Br., a smaller tufted grass, less plentiful, and with a more restricted range, are all present.

Goodenia ovata Sm. has formed a series of clumps on soil deposits in the bed of the stream winding through the dune from the foot hills to the strand at Long Bay. The stems

[1] Proc. Linn. Soc. N. S. Wales, Vol. XLII, p. 247.

and branches of the plants are interlocked for mutual protection against dislodgment by flood waters. The bulk of the ligneous vegetation has been removed from the comparatively flat stretch of dune at the rear of the strand, two Banksias, *B. æmula* R. Br., and *B. serrata* L., representing the remnant of the arboreal growth.

These two species may be easily confused when growing on the exposed headland, where they both approach the shoreline, in places, to within a few feet of the escarpment and are reduced by exposure to low spreading shrubs. When growing under normal conditions the habit of these plants is a sufficient guide to their identity, *B. æmula* rarely exceeding the dimensions of a large shrub, its stem furnished with branches almost to the base, *B. serrata* attaining the rank of a medium sized tree, with a clear trunk several feet from the ground. Photographs of examples of both species domiciled at no great distance apart on the dune flat at Long Bay, showing their distinctive habit have been incorporated by Mr. Maiden in his "Forest Flora of New South Wales," iv, p. 30, 1909. *B. serrata* usually maintains a large colony, covering in some localities, several acres of ground, its confrere, less exclusive, usually assembling in small groups or growing as individual specimens among the shrubbery.

On the cleared area several herbaceous species with subterraneous root systems of vegetative reproduction, too deep to be destroyed by fires, which are of frequent occurrence, have seized the opportunity for colonisation, and taken possession of the vacant space, either as segregated assemblies or in association. Of these the cosmopolitan Bracken-fern, *Pteridium aquilinum* (L) Kuhn., is the most aggressive, extending over the greater part of the dune flat and invading the Banksian arboretum, its greedy rhizomes absorbing the small quantity of nutriment available in the

poor sandy soil, and starving out its less perfectly equipped competitors, or smothering them with its spreading fronds. The latter is of a tough consistence and requires little moisture, the succulent rhizomes storing and regulating the water supply.

The Blady-grass, *Imperata arundinacea* Cyr., is one of the few plants associated with the Bracken, which the latter is unable to suppress. Its rhizomatic system is but little inferior to that of its larger confrere, and its flag, though broad and flat, has a membraneous drought resistant tissue, the elongated culms with the blade held vertically, running up to the light through the interstices of the fern fronds. *Dianella revoluta* is also capable of establishing its colony within the confines of the Fernery, but does not consort with the Bracken as freely as does the Blady-grass.

At the southern end of the beach a small colony of Thatch-reed, *Phragmites communis* Trin., has obtained a precarious footing in a drainage channel on the rock shelves at the base of the escarpment, which stretches, in comparative shelter for a considerable distance to the ocean headland. In some of the reaches of Cook's River, this reed lines the banks with an exclusive formation, descending into the stream shallows to a depth of a few feet, its stout, closely interlocked rhizomes securing a foothold for the community and incidentally protecting the muddy river bank from tidal erosion. Its climatic adaptability and vigorous growth, are attested by a cosmopolitan distribution, and an exceptional capacity for excluding competitors.

The heath-like *Micromyrtus microphylla* Benth., covers small patches of shallow, moist soil on the rocky hillside, its close formation admitting only mossy growths, or other diminutive shade loving plants. The Hop-bush, *Dodonœa triquetra*, has, on the headland, quickly responded to exposure by reducing the size of its leaves, those on plants

on the verge of the escarpment measuring less than one-third of the length of the leaves on bushes growing five yards inland. *Kennedya monophylla* Vent., scrambles over the boulders and among the low spreading shrubs on the hillside. Preferably a trailer, it is compelled to climb in search of light when growing, as occasionally happens, in a dense shrubbery.

The shrubby *Petrophila pulchella* R. Br., with finely dissected cylindrical foliage, suitable for this dry exposed station is well represented, and the prostrate *Gompholobium glabratum* DC., a weak, wiry-stemmed undershrub, is occasional on the hillside.

Nearing the ocean headland in an area of sandy to peaty soil, from occasionally wet to permanently swampy, several species find a more or less suitable habitat. Of these *Styphelia esquamata* Spreng., is the most drought resistant, frequently ascending to the dry crown of the hill. It avoids shade but does not favour a hot climate. It extends southwards to Victoria, and is found on the higher slopes of the Blue Mountains. *Mirbelia reticulata* Sm., usually a swamp dweller, and normally prostrate, is here represented by a few plants which have invaded a clump of *Banksia ericifolia*, and struggled upwards through its dense foliage to the light.

A solitary specimen of the green-flowered *Callistemon pinifolius* DC., was noted on the hillside. This species occasionally takes possession of a peaty basin among the inland sandhills, but is better represented, though less communal, on the Wianamatta Shale flats in the Clyde, Granville, and Parramatta districts. Though edaphically adaptable it has a limited range, extending northerly from Port Jackson to the Hunter River, and west to the foothills of the dividing range, ascending the Blue Mountains to Glenbrook, and the southern highlands to Picton.

The aromatic leaved *Melaleuca thymifolia* Sm., does not venture far from the swampy area, and *Sprengelia incar-*

nata Sm., a species with xerophytic, papery petalled flowers and protective sheathing based leaves, is even more closely confined to this habitat.

On the exposed hillside facing the ocean, a fire had recently burned off the scrub, and several species were making characteristically enlarged new growth (reversion shoots). The increased size of the leaves of the young growth of *Ruelingia hermanniæfolia* Steetz., which have retained their luxuriance until the plants have reached the flowering stage, are in marked contrast to the harsh scanty foliage of the older plants unscathed by the fire. The new crop of *Amperea spartioides* Brongn., whose leaves under normal conditions are reduced to scales, is amply clothed with obovate leaves. Plants of *Lasiopetalum ferrugineum* Sm., visited by the fire, have developed leaves much broader and more cordate at the base than those on the uninjured plants. [The Blue Mountain form of this species, *L. rubiginosum* A. Cunn., reduced by Bentham, Fl. Austr. i, 263, to a var. of *L. ferrugineum*, maintains the broad cordate leaf in the adult stage of growth.]

Some outlying plants of *Conospermum ellipticum* Sm., creep down the hillside towards the escarpment, but it is much more plentiful a few miles further inland. It has a short coastal range from Port Jackson to the Illawarra, and is recorded from the Blue Mountains, but the latter locality is somewhat doubtful.[1] Two Opercularias, *O. diphylla* Gaertn., with short stout branches and an erect habit, and *O. aspera* Gaertn., usually a trailer but here restricted to a divaricate tuft, were found associated in a soil pocket.

On a small sand-patch at the base of the escarpment on the southern headland of Botany Bay, *Convolvulus soldanella* was noted climbing to a height of several feet through

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[1] Proc. Linn. Soc. N.S. Wales, XL, p. 407 (1915).

a bush of *Styphelia Richei.* The slender weedy *Apium leptophyllum* F.v.M., is occasional on the slope of the hill. Though confined chiefly to the tropics, both in Africa and America, it extends as far south as Victoria on the Australian coast. The scantily tufted *Andropogon refractus* R. Br., has here shown a considerable degree of plasticity, the paucity of its stool alone indicating dissatisfaction with the harsh environment, an extreme change from the tropical jungle in which it obtains its optimum growth.

In a swampy hollow on the headland facing the ocean, a plant association occurs in which several species occupy more or less strictly defined zones. On its border, in a comparatively open shrubbery of *Leptospermum lœvigatum*, several plants of the flaccid leaved *Solanum vescum* F.v.M., a shade loving mesophyte, are established. This species may be readily separated from its relative, *S. aviculare* Forst., (with which it is united by Bentham, Fl. Austr., iv, 47) by its sessile decurrent leaves and green globular berries. The leaves of *S. aviculare* taper into a petiole and are not decurrent, the berries are ovoid and yellow. In this shady grove the banks of the drainage channel supplying the swamp are lined by the creeping (stoloniferous), *Viola hederacea* Labill.

In the open country the moist fringe of the swamp is sparsely clothed by the prostrate *Epaltes australis* Less., (whose presence is an indication of sour ill-drained land) the limitation of its mat, and reduction of foliage as the aquatic region is approached, denoting its disinclination for further submergence. Entering the swamp a comparatively level zone is met, occupied chiefly by rushes, in which the close-tufted *Restio complanatus* R.Br., is well represented. The Fringed Violet, *Thysanotus junceus* R.Br., is occasional in this situation, but is better suited on the sandstone hillsides. This species has a limited coastal range, the

Port Hacking district representing its southern boundary, and it extends north into Queensland.

In the shallows of the submerged area, *Goodenia paniculata* Sm., finds a congenial habitat, the basal leaves of the plants drooping, and forming rosettes on the unstable mud as the water recedes. In this zone the firm erect Rushes, are replaced by the flaccid trailing Sedges, among which *Scirpus inundatus* Poir., with its closely packed system of ramifying stems and branches, is prominent. The Swamp-millet, *Isachne australis* R. Br., trails over the smaller growths, descending at intervals to root its stems among the Sphagnum which carpets the pool. In close proximity a trailing Composite, *Enhydra fluctuans* Lour., seeks the support of the taller swamp growths to secure an aerial position for flower production. It is a tropical species, extending to India, and has not been noted south of Port Hacking. Though recorded from several littoral stations it is rarely collected owing to its choice of habitat, the infrequency of its occurrence, and its insignificant floral display.

The woolly *Philydrum lanuginosum* Bks., one of the plants over which the *Enhydra* scrambles, inhabits the deeper water of the swamp. This species also extends to the tropics viâ the Malayan Archipelago, and persists as far south as Victoria.

Beyond the headland on the dunes stretching south to Cronulla, *Acacia longifolia* and its var. *Sophoræ*, commingle in a shallow valley on the embankment plateau. The latter does not extend far inland, and displays a partiality for the dune, rarely ascending the rocky escarpment or hillside. The typical *A. longifolia* is less restricted in its inland range, and frequents both dune and rocky headland. The var. *prostrata* of Moore and Betche,[1] is also present on the embankment, and is merely a wind-swept form of *A. longi-*

[1] Handbook Flora of New South Wales, p. 170.

folia typica. In the centre of the depression, *Cupaniopsis anacardioides* Radlk. is a shrub of four to six feet, but as it retreats down the sheltered rearward slope of the dune embankment it increases in height, until on reaching the flat at the base of the slope it has attained its normal arboreal growth.

On the rocky ledges of the escarpment on the headland near Port Hacking, the exposure has again reduced it to a shrub. The fragrant flowered Coast Mignonette, *Stackhousia spathulata* Sieb., a prostrate succulent herb, creeps out of the valley to the verge of the frontal embankment. This species is doubtfully recorded by Bentham (Fl. Austr. i, 406) from the grasslands of the interior, but, as he suggests, it has doubtless been confused with *S. monogyna* Labill., which is common in grazing country throughout the State. It is not represented in the National Herbarium from any station other than the coastal beaches.

On the rearward slope of the embankment in the shelter of the arboretum of *Cupaniopsis anacardioides*, and *Banksia integrifolia*, several shade loving species are established, of which *Vitis clematidea* F.v.M., a tendril climber, and *Solanum pungetium* R. Br., a trailer, are typical representatives. The introduced *Œnothera longiflora* Jacq., has found in the loose sandy soil a suitable habitat, and has spread in close ranks along the unoccupied ridges.

On the headland south of Cronulla Beach the hardy *Monotoca scoparia* R. Br. mingles sparsely with the shrubs on the rocky hillside, and the herbaceous *Goodenia heterophylla* Sm., sends up straggling stems in the open spaces. The xerophytic *Trachymene Stephensonii* Turcz., does not discard its leaves in this situation, to the same extent as when growing in the shallow soil on rock benches in the flat ill-drained country near Botany, the centre of its activity.[1]

[1] Proc. Linn. Soc. N.S. Wales, 1916, p. 219.

In a shallow swampy basin *Calamagrostis æmula* Steud., a weak grass with a feathery inflorescence, is growing side by side with the introduced cosmopolitan Fox-tail grass, *Polypogon monspeliensis* Desf., a halophilous species which favours the salt-marsh and estuary. Among the dense growth in the centre of the swamp, the slender stemmed *Pultenæa dentata* Labill., runs up to the light. This species simulates its congener, *P. incurvata* A. Cunn., which frequents a similar situation in the swamps further inland.

On the rocky escarpment facing the ocean, where the headland commences to curve towards the entrance to Port Hacking, an example of the rare *Ficus Henneana* Miq. was noted growing in a rock crevice, and sprawling outwards over the cliffs. An interesting note on this species is given by the Government Botanist, Mr. J. H. Maiden in his Forest Flora of New South Wales, ii, 100 (1905).

Explanation of Plates.

Plate VII.

Fig. 1. A wind-torn gap in the dune embankment, Deewhy Beach.

Fig. 2. *Festuca littoralis* forming horizontal ridges on the sand which has been removed from the gap by the wind and deposited at the rear of the embankment.

Plate VIII.

Fig. 3. *Festuca littoralis* building a hummock of sand in the gap.

Fig. 4. A colony of *Festuca littoralis* forming a series of miniature mounds on the floor of the gap.

Plate IX.

Fig. 5. Trailing stems of *Spinifex hirsutus* creeping down the slope from the top of the dune embankment to join *Festuca littoralis*, Deewhy Beach.

Fig. 6. Trailing stems of *Spinifex hirsutus* binding the sand on the frontal slope of the dune embankment, Maroubra Bay.

Fig. 1.

F. W. Carpenter, Photo. Fig. 2.

F. W. Carpenter, Photo. Fig. 3.

L. T. N. Hamilton, Photo. Fig. 4.

F. W. Carpenter, Photo

Fig. 5.

L. T. N. Hamilton, Photo.

Fig. 6.

F. W. Carpenter, Photo. Fig. 7.

L. T. N. Hamilton, Photo. Fig. 8.

Fig. 9.

F. W Carpenter, Photo. Fig. 10.

Fig. 11.

L. T. N. Hamilton, Photo.

Fig. 12.

L. T. N. Bamilton, Photo. Fig. 13.

F. W. Carpenter, Photo. Fig. 14.

Plate X.

Fig. 7. *Festuca littoralis* building a horizontal bank on the beach at Deewhy.

Fig. 8. *Hibbertia volubilis* holding the sand on an exposed ridge, Deewhy Beach.

Plate XI.

Fig. 9. *Solanum sodomæum* retaining the crest of a hillock at Maroubra Bay.

Fig. 10. *Xerotes longifolia* protecting the verge of the eroded dune embankment, Maroubra Bay.

Plate XII.

Fig. 11. *Correa alba* exhibiting a flattened contour as a result of exposure to the on-shore wind, Maroubra Bay.

Fig. 12. *Leptospermum lævigatum* compressed horizontally by the on-shore wind. Height at rear 12 feet. Deewhy Beach.

Plate XIII.

Fig. 13. *Scævola suaveolens* forming a carpet 18 feet by 24 feet Maroubra Bay.

Fig. 14. *Hydrocotyle umbellata* var. *bonariensis* ascending from the lagoon to the top of a dry sandhill, Deewhy Beach.

SOME DETERMINATIONS OF THE HEAT CONDUCTIVITY OF SELENIUM.

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IT is well known that the electrical conductivity of selenium can be varied over a wide range by suitable alterations in the method of preparation, or in the temperature and degree of illumination at the time of testing. If these changes are due to variations in the number of free electrons present in the substance, we should expect to find corresponding changes in the thermal conductivity under similar conditions.

Some investigations on this point have been made by Bellati and Lussana,[1] and by L. P. Sieg.[2] In both cases attention was concentrated mainly on the effect of illumination, and only relative measurements were made. In the work which is to be described here, the influence of the method of preparation, the age of the specimen, and the temperature of testing have been investigated, all measurements being made with the selenium in darkness.

The results obtained are such as might be expected from a consideration of the values of the electrical conductivity obtained by observers working with selenium cells. It is found that the thermal conductivity varies over a wide range, being affected by those conditions which influence the electrical conductivity. In all the cases which have been examined, both thermal and electrical conductivities

[1] Gazz. Chim. Ital., 17, 391. [2] Phys. Rev., 6, p. 213, 1915.

are changed in a similar manner, but the relative alteration produced in the former is, in general, smaller than that brought about in the latter property by the same cause.

Although the values of the conductivity have been obtained throughout in absolute units, very little weight should be attached to the actual figures given for the crystalline form. For it appears probable that in any preparation of crystalline selenium, spontaneous changes take place for a long time after preparation, and, in addition, the slight alteration of temperature which is necessary before any measurement can be made, is able, under certain conditions, to produce a considerable change in the conductivity.

The results may be summarized briefly as follows:—

(1) The thermal conductivity of vitreous selenium at 25° C. was found to lie between 0·000293 and 0·000328.

(2) The conductivity of crystalline selenium at 25° C. varied from 0·00070 to 0·00183. In general the conductivity increased with the temperature of preparation, but diminished with age.

(3) In all the cases examined, the temperature coefficient was positive.

Method of Investigation.

The method used was that described by C. H. Lees.[1] The selenium was tested in the form of a disc 6·5 cm. in diameter, and of the order of 0·5 cm. in thickness. All temperatures were measured by means of copper-eureka thermo-couples which were carefully calibrated at the commencement of the work. A year later other similar thermo-couples were substituted, and new calibration readings taken. The series method of measuring thermo-electromotive-forces employed by Lees was not used. Each

[1] Phil. Trans., A, 1898, p. 399.

e.m.f. was measured independently by means of a Wolff potentiometer, and the temperature calculated from tables prepared from the calibration readings. The only other alteration in the method was the substitution of a Weston milliammeter and voltmeter for the wattmeter which Lees used to measure the rate at which heat was supplied.

The discs were first prepared in the vitreous[1] form by pouring molten selenium into a hot iron mould. These were transformed to the crystalline state by heating in an oil oven to some chosen temperature. They were then ground with fine emery and polished.

On account of the contraction which takes place when changing from the vitreous to the crystalline form, some difficulty was experienced owing to discs cracking during heating. This was overcome by performing all operations very slowly. The vitreous discs were gradually cooled from the molten state, and the oven was so regulated that the required temperature was only reached after seven hours continuous heating. This temperature was maintained for one hour, and the disc was allowed to cool slowly in the oven. By this means crystalline discs were prepared at temperatures which range from 160° C. to 214° C. Some specimens were also tested in the vitreous form.

If the bath in which the discs were tested were heated by a suitable current in the bath heating coil, the conductivity could be measured at any temperature higher than that of the room. An upper limit is, however, placed on the temperature of testing by the fact that selenium is so readily changed by heating even to comparatively low temperatures. Thus the available range was only about 25° C. to 55° C. In order to obtain sufficiently steady temperature conditions, it was found necessary to keep the current in the heating coil constant for approximately six

[1] A. P. Saunders, Jour. Phys. Chem., Vol. IV, p. 423, 1900.

hours before any reading could be taken. When this steady temperature was reached, two sets of readings were taken, separated by an interval of half an hour. Thus in Table I we have, at every temperature, two values of the conductivity, each of these being calculated from the mean of a number of readings.

Table I also shows the general order adopted for any disc. The conductivity was measured first at room temperature, then at several higher temperatures, and finally the readings at room temperature were repeated. In most cases this procedure has been repeated at intervals which extend up to one year from the date of preparation.

Sources of Error.

The errors involved were necessarily large. They naturally fall into two divisions, those due to the imperfections of apparatus and method, and those due to such changes in the selenium as were beyond control.

With the instruments used, the errors of the first class should not have exceeded 1%, these probably being small in comparison with the errors of the second class.

The latter appear to be due chiefly to heating effects, and are most marked in the case of newly prepared crystalline discs. Two types of irregularity were of frequent occurrence:—

(i.) In many cases the first reading taken for any crystalline disc at a temperature above that of the room was abnormally high.

(ii.) The conductivity at room temperature was almost invariably increased after the measurements at higher temperatures had been made, but the actual increase thus produced varied greatly, even in the case of discs which had apparently been treated in exactly the same manner.

Results.

Eleven discs have been prepared, five vitreous and six crystalline, the nature of the results obtained being illustrated in Tables I, II and V.

Table I.—*Conductivity of Vitreous Selenium.*
Disc 2, prepared on 21 August, 1916.
Thickness of disc = 0·7523 c.m.

Reading.	Date.	Temperature of disc.	Temperature gradient across disc.	Heat supplied (calories per sec.)	Thermal Conductivity.
(i)	22 Aug., 1916	23°·80 C.	5·39	0·1724	0·000324
(ii)		23·92	5·46	0·1724	0·000319
(iii)	23 Aug., 1916	33·69	4·93	0·1651	0·000345
(iv)		35·94	4·98	0·1650	0·000342
(v)	24 Aug., 1916	40·92	4·80	0·1655	0·000358
(vi)		41·21	4·79	0·1655	0·000359
(vii)	25 Aug., 1916	24·17	5·03	0·1638	0·000333
(viii)		24·46	5·05	0·1638	0·000332
(ix)	28 Aug., 1916	57·15	4·49	0·1676	0·000385
(x)		57·48	4·45	0·1676	0·000389
(xi)	29 Aug., 1916	25·14	5·03	0·1638	0·000337
(xii)		25·17	5·00	0·1638	0·000339

Table I, which shows one complete set of measurements for the vitreous disc 2, indicates the typical increase in conductivity which accompanies increase in the temperature of testing. This feature is common to both vitreous and crystalline preparations, as is shown in Table II.

Table II.—*Thermal Conductivity of Crystalline Selenium.*
Disc C, prepared at 180° C. on 15 June, 1916.
Thickness of disc = 0·5774 c.m.

	Date.	Temperature of disc.	Thermal Conductivity.	Electrical Conductivity (in arbitrary units)
I.	19 July, 1916	26°·90 C.	0·00150	1·55
	20 July, 1916	35·69	0·00152	3·76
	21 July, 1916	46·01	0·00158	4·63
	24 July, 1916	26·37	0·00151	...
	25 July, 1916	52·61	0·00159	4·56
	26 July, 1916	27·05	0·00152	1·58
II.	15 Sept., 1916	32·44	0·00104	0·94
	18 Sept., 1916	41·10	0·00109	1·60
	19 Sept., 1916	52·59	0·00116	2·43
	20 Sept., 1916	32·41	0·00104	0·96
III.	3 July, 1917	28·48	0·00099	...
	4 July, 1917	56·46	0.00134	...
	5 July, 1917	27·19	0·00111	...
	6 July, 1917	27·16	0·00110	...

The relation between the temperature of measurement and the conductivity was found to be approximately linear. If we express the conductivity (K) at any temperature t by the equation

$$K_t = K_{25}\left[1 + (t - 25)\alpha\right]$$

where K_{25} is the conductivity of that specimen at 25° C., the values of α range from 0·006 to 0·009 for the vitreous discs examined. For crystalline selenium α varied from 0·003 to 0·010, the upper limit being generally approached in the case of older discs.

In Table II are shown the summarized results for the crystalline disc C, illustrating the decrease in conductivity with the age of the specimen.

The values of the conductivity at 25° C. of all the vitreous discs prepared are collected in Table III. In the first three cases no special precautions were taken to remove impurities, but the fourth and fifth discs were prepared from highly purified selenium.[1]

Table III.—*Thermal Conductivity of Vitreous Selenium.*

Disc.	Age of Disc.	K_{25}
1	7 years	0·000328
2	5 days	0·000325
2 (retested)	1 year	0·000329
3	10 days	0·000293
3 (retested)	1 year	0·000300
4	10 days	0·000327
5	2 days	0·000312

These results suggest that the conductivity of vitreous selenium is independent of the age of the disc, and is not greatly affected by the presence of impurities. The variations which occur are possibly due to the existence of small traces of crystalline selenium in the vitreous discs.

[1] Prepared by R. Threfall, Proc. Roy. Soc. A. Vol. 97, p. 167, 1907.

The values of K_{25} obtained for crystalline selenium are given in Table IV.

Table IV.—*Thermal Conductivity of Crystalline Selenium.*

Disc.	Temp. of preparation.	I.		II.		III.	
		Age.	K_{25}	Age.	K_{25}	Age.	K_{25}
		Days.		Days.		Year.	
A	160°C.	11	0·00110	164	0·00081	1	0·00070
B	170	16	0·00157	134	0·00130	1	0·00097
C	180	38	0·00149	95	0·0099	1	0·00097
D	192	28	0·00161	148	0·00111	1	0·00120
E	200	9	0·00168	156	0·00120	1	0·00110
F	214	42	0·00183	...	...	1	0·00139

Two general tendencies are apparent, firstly the decrease in conductivity with the age of the disc, and secondly the increase in conductivity which accompanies an increase in the temperature of preparation. Departures from these general principles will be noted in the case of discs B and D (III). In preparation the former was heated for a longer period than any of the other discs, and, by accident, the bath was kept at a temperature of 57° C. for twenty-four hours shortly before the readings for D (III) were taken. This appears to have produced some permanent change in the substance, for when measured six weeks later the value of K_{25} for disc D was found to be 0·00119.

Table V has been included in order to illustrate what has previously been said with respect to the accuracy of the work. This disc, though apparently treated in exactly the same manner as the others, fails to give a linear relation between conductivity and temperature. The increase in the conductivity at room temperature is also very much larger than in the normal case shown in Table II.

The existence of such irregularities renders the numerical values of the conductivity unreliable, but there appears to be definite evidence that the thermal conductivity is

affected by factors which influence the electrical conductivity, in the manner stated at the beginning of this paper.

Table V.—*Thermal Conductivity of Crystalline Selenium.*

Disc D, prepared at 192° C. on 14 June, 1916.

Thickness of disc = 0·6749 c.m.

Date.	Temperature of disc.	Thermal Conductivity.
6 July, 1916	26·64° C.	0·00162
7 July, 1916	34·22	0·00169
10 July, 1916	41·26	0·00168
12 July, 1916	27·11	0·00165
13 July, 1916	51·99	0·00175
18 July, 1916	25·77	0·00173

While the discs were in position for the thermal determinations, a few measurements of the electrical conductivity were made, typical figures being shown in Table II. The results may be summarised thus :—

(i) The temperature coefficient of the electrical conductivity is positive.

(ii) The conductivity of crystalline selenium is much greater than that of the vitreous form; it increases with the temperature of preparation, but decreases with the age of the disc.

(iii) In many cases irregularities in the value of the thermal conductivity are accompanied by corresponding, but more marked, variations in electrical conductivity.

These results indicate a close, though probably complex, relationship between the thermal and electrical conductivities, and are such as might be expected if the variations in the latter were due to changes in the number of free electrons present in the substance.

In conclusion, I wish to express my indebtedness to Professor O. U. Vonwiller, under whose direction this work was done, and to Mr. J. J. Forster B.Sc., for his assistance in taking the early measurements.

NOTES ON THE EARLY STAGE OF DEVELOPMENT OF *Lysurus Gardneri (L. australiensis).*

By J. BURTON CLELAND, M.D., and EDWIN CHEEL, Botanical Assistant, Botanic Gardens, Sydney.

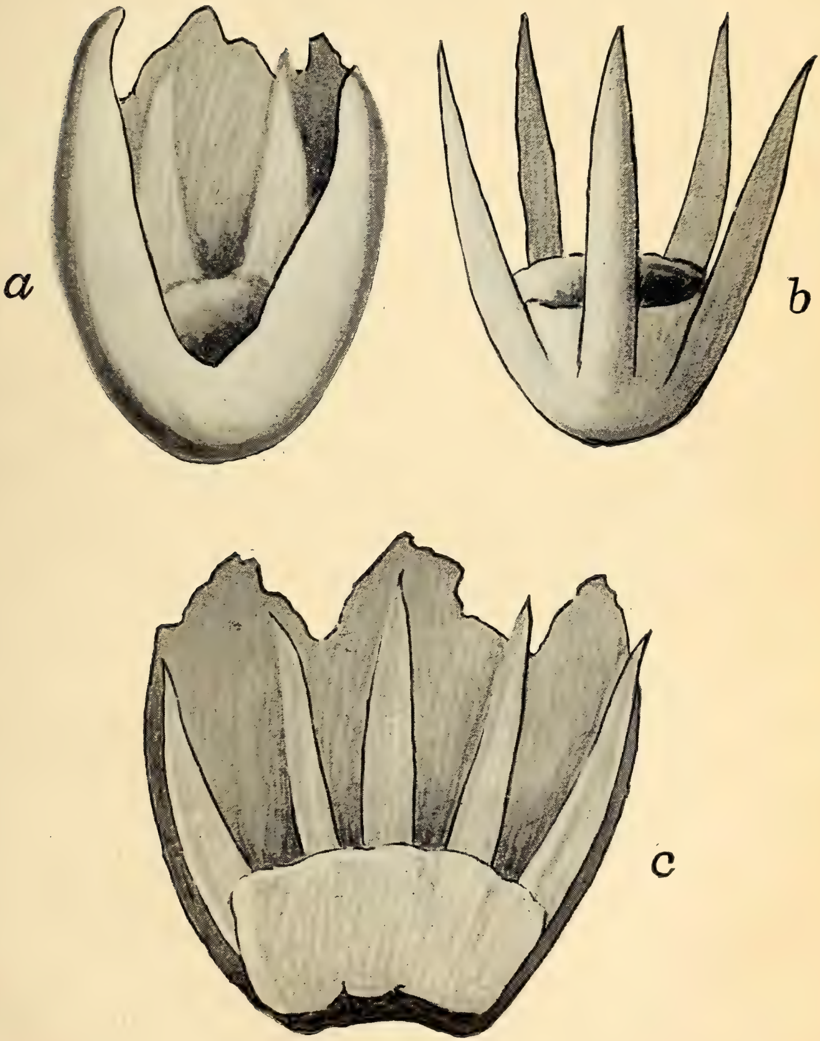
With Plate XIV.

[*Read before the Royal Society of N. S. Wales, October 3, 1917.*]

IN a paper published by this Society (Vol. XLIX, p. 204, 1915), we recorded the distribution, and noted certain characters of development of this species. In the following notes we draw attention to certain internal structures that have apparently not been observed previously.

In the very early stage of development there appears to be a thin whitish membrane within the jelly-like egg or volva, quite distinct from the substance of the egg itself. This whitish membrane holds the receptacle in position. For example, when the volva splits open, there is seen at the base of the volva and within it, a definitely shaped cup in which the base of the receptacle is fixed. At the base of this white membranous cup, and consolidated with it, are five lanceolate-shaped lobes which have held the arms of the receptacle in position. When the plant reaches maturity, it is evident that the five arms held in position by this whitish inner membrane break away, the receptacle thus liberated, giving a sudden spring like a jack-in-the-box and rupturing the upper part of the volva. The receptacle is thus quite free, and leaves the thin whitish membranous cup and lobes adhering to the base of the dull coloured jelly-like volva.

The gleba or spore-bearing mass is contained within the five arms of the receptable, and when the latter elongates and is forced through the volva, the arms finally open out and thus liberate the slimy mass of greenish-brown gleba.


a
b
c

The specimen from which the accompanying plate was made, was collected at Kogarah, by Mr. J. Corkery, in April, 1916.

We are indebted to Miss M. Flockton for the drawing.

EXPLANATION OF PLATE XIV.

a. Volva showing the membranous whitish cup and lobes *in situ*.

b. Membranous cup and lobes dissected.

c. Volva opened out to show the arrangement of the membranous cup and lobes.

A FOSSIL ISOPOD BELONGING TO THE FRESH-WATER GENUS PHREATOICUS.

By CHAS. CHILTON, M.A., D.Sc., M.B., C.M., LL.D., F.L.S., C.M.Z.S.,
Professor of Biology, Canterbury College, New Zealand.

(Communicated by R. J. TILLYARD, M.A., etc.)

[*Read before the Royal Society of N. S. Wales, October 3, 1917.*]

CONTENTS.

1. Introduction.

In May, 1917, Mr. R. J. Tillyard, who is investigating the Mesozoic and Tertiary Insects of Queensland and New South Wales, wrote to me saying that among the fossils from the Wianamatta Shale of St. Peter's Brickworks, Newtown, Sydney, New South Wales, he had several speci-

mens of a Crustacean which he felt convinced belonged to the genus *Phreatoicus*, and he very kindly offered to hand over the specimens to me for examination. In his paper describing the fossil insects, (1916, p. 11),[1] he had mentioned the fossil Crustacean as "a fine Peracarid Crustacean," and in his MS. he had given it the provisional name of *Phreatoicus wianamattensis*.

I received the specimens on June 16th, and a careful examination soon convinced me that Mr. Tillyard was perfectly correct in his identification, and that the specimens all belonged to a single species of *Phreatoicus* closely similar to existing Australian species, such as *P. australis* Chilton and *P. shephardi* Sayce. None of the specimens is complete, and the head and first peraeopods are not clearly represented in any of them, but several of the other peraeopods are very distinct in some of the specimens and so are the segments of the peraeon (with the exception of the first) and of the pleon. The downward prolongation of the segments of the pleon, which is so distinctive a character of *Phreatoicus*, is quite evident in most of the specimens, and the conical terminal segment is clearly shown in one. These points, with the evidence afforded by the peraeopods, some of which are very perfectly preserved, leave no doubt as to the correctness of the identification.

The stratigraphical features relating to the Wianamatta Shales are given by Mr. B. Dunstan, Chief Government Geologist of Queensland, in the introduction to Mr. Tillyard's paper, and he concludes his remarks by stating that—

"The shales containing the fossil remains—insects, fishes, labyrinthodonts, coprolitic fragments and plants—belong to the Wianamatta Shales, a series probably equivalent to the Upper Clarence Series in Northern New South Wales, and the Darling

[1] The references are given by the year of publication to the list at the end of this paper.

Downs-Walloon Coal Series in Southern Queensland. This position for the St. Peter's fossil beds places the horizon in the Jurassic and above the fossil bed at Ipswich, which is probably Upper Triassic." (1916, p. 10.)

Further information is given by Mr. Tillyard in his paper under the "Summary of St. Peter's Results" (1916, p. 43).

In forwarding the specimens Mr. Tillyard writes on May 31st, 1917:—

"The beds are usually classed as Trias-Jura, but evidence is accumulating that will probably place them in the Upper Trias, probably as the nearest Australian equivalent of the Rhætic."

The species of *Phreatoicus* is represented in the specimens sent to me by about ten impressions. Of these Mr. Tillyard writes (June 5th, 1917):—

"Most of the Crustacea appear to have been found in the actual 'Nodules' of the 'False Coal' band formation, from which the Fish, the Unios, and most of the insects were also derived. Some, however, come from the paler unaltered shales with plane fracture-surfaces. All the specimens are much carbonised, so you will have to rely solely on outline drawings to illustrate the fossils." In addition to the specimens sent to me there are, Mr. Tillyard says, "a large number of less satisfactory specimens as well, some being on large hand-specimens of rock of considerable weight."

All the specimens are the property of Mr. B. Dunstan, Chief Government Geologist of Queensland.

Of the specimens described below, the first three are from impressions on dark coloured rock, the remainder are from the paler unaltered shales.

I proceed to describe these impressions in detail, starting with the most complete, *i.e.*, in the order in which I first examined them. The measurements given were made direct from the specimens without reference to specimens of the existing species, comparison with which was not made till after I had examined all the fossil specimens.

2. Description of Specimens.

SPECIMEN 1, Fig. 1. (Block 237, larger impression.)

Fig 1. *Phreatoicus wianamattensis*, (No. 237*a*); × 5.

This impression is about 18 mm. in length, but the head and one or two anterior segments of the peraeon are wanting, and so also is the terminal portion of the pleon. There are indications of five peraeopoda, some of them being remarkably perfect, and enabling the separate joints to be determined with considerable certainty. These apparently represent peraeopoda 3, 4, 5, 6 and 7, that is to say, those attached to the five posterior segments of the peraeon. Of these, peraeopoda 3 and 4 are very distinct, and quite similar. In each the basis is somewhat expanded; the ischium moderately long; the merus broader, subtriangular and produced at the antero-distal angle into a lobe extending fully half way along the carpus; the carpus appears to be about as long as the propod, and of rather greater width; the dactyl is about half as long as the propod and slightly curved, being in both peraeopoda directed backwards. Peraeopod 5 is about as long as either of the two preceding, but evidently belongs to the posterior series of three, having its dactyl facing forwards; the basal joint is about as broad as that of peraeopod 4, and the other joints show a general agreement, the merus, however, being not so much pro-

duced at the postero-distal angle. The 6th peraeopod is slightly longer than the 5th, but shows quite the same structure, though the more distal joints are rather obscure. The 7th peraeopod is still less perfectly preserved, but is evidently longer than the sixth, apparently reaching backwards as far as the posterior margin of the 4th segment of the pleon; only the distal joints are represented; the merus does not appear to be expanded.

Of the pleon, the first four segments can be made out, particularly the downward prolongations of the pleural portions, which are very distinct. Of these, the first is the shortest or narrowest, and is not produced so far downwards as the second, which is considerably broader than the first and has its anterior margin rounded, somewhat as in the first segment. The third segment appears about as long as the second, and reaches downwards to about the same level, both the anterior and posterior angles being rounded. The impression of the 4th segment is less distinct, but it appears to be about as long as the third, and produced a little further downwards; its posterior margin shews a slight concavity in the middle portion. The remaining segments are absent. The upper portion of these pleon segments cannot be made out with any certainty, but the distinctly marked pleura, as described, are so characteristic of *Phreatoicus* that they alone would be sufficient evidence that the impression is actually that of a *Phreatoicus*, and this conclusion is abundantly confirmed by the well preserved peraeopoda. The impressions of the segments of the peraeon are by no means clear, but they appear to represent the five posterior segments and to correspond to the peraeopoda already described; the dorsal margin is fairly distinct, so that the depth of the segments can be measured with fair accuracy. The depth of the peraeon appears to be rather greater in comparison with that of

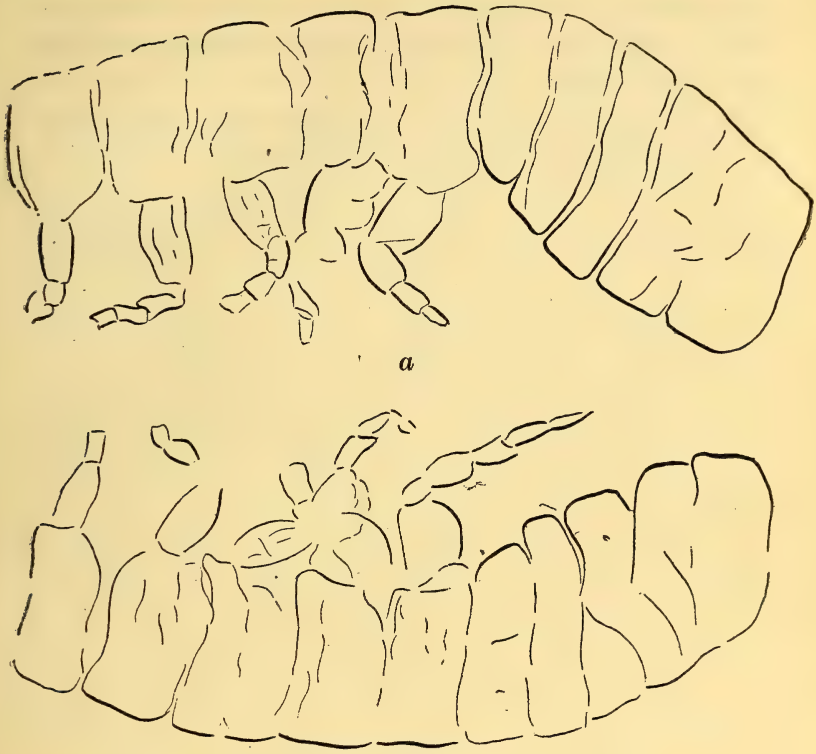
the pleon than in existing species, but this is probably merely the result of compression, which would produce a greater effect on the subcylindrical peraeon segments than on those of the pleon, since this is already considerably flattened in the living animal.

The following measurements may be given in addition to the description:—Total length of impression 18 mm., so that the whole animal would have measured probably about 23 mm. Length of peraeopods 3 and 4, 4·5 mm.; of 5, 4 mm.; of 6, 4·5 mm.; of 7, 5 mm. Depth of peraeon segments 3 mm.; depth of pleon segments 5 mm. (? or more).

On the block that bears Specimen 1 there are also two imperfect impressions, but they do not show any additional details.

Specimen 2, Fig. 2, *a* and *a′*. (Block 240, the larger impression, with its counterpart on Block 241).

This specimen is considerably larger than specimen 1, the total length of the impression being 23 mm. It shows apparently the five or six posterior segments of the peraeon, with portions of the corresponding peraeopoda, and the first five pleon segments, the fifth being more or less imperfect; the total length of this animal would therefore probably have been about 30 mm. The peraeopoda are less distinctly shown than in specimen 1; but, as in that specimen, the three posterior ones are directed backwards and the anterior ones forwards. Of peraeopod 2 only one or two of the basal joints are shown indistinctly. Peraeopod 3 shows portions of the basis and three other joints, apparently merus, carpus and propod. Peraeopod 4 is similar, but less distinct. Peraeopods 5 and 6 appear to be overlapping, and are not distinct, though the broadened basal joint is pretty clearly shown. Peraeopod 7 is more distinct, and shows a structure apparently corresponding



a

a′

Fig. 2. *Phreatoicus wianamattensis*, (No. 240 and 241; *a*, impression, *a′*, its counterpart. × 4.

with that of existing species, such as *P. australis;* the basis is large and broad, the ischium long, merus of about equal length and not broadened nor produced at the postero-distal angle; the rest of the limb is not distinct, but the whole reaches apparently as far back as the middle of the 4th pleon segment. Of the pleon, the first five segments can be made out with tolerable certainty, though the division between the 4th and 5th is not clear. These segments agree pretty closely with those already described for specimen 1. The inferior margin of the first segment

is indistinct, but apparently it does not reach down so far as that of the second segment. The terminal segment of the pleon is absent.

The depth of the peraeon segments is about 4 mm. and the greatest depth of the pleon 7 mm.

SPECIMEN 3, Fig. 3, *b* and *b′*. (Block 240, the smaller impression, with counterpart on portion of Block 241).

b

b′

Fig. 3. *Phreatoicus wianamattensis,* (No. 240 and 241); *b,* impression, *b′,* its counterpart. × 5.

This specimen is rather smaller than specimen 1, the total length of the impression being 13 mm. It shows part of the third segment of the peraeon and segments 4, 5, 6 and 7, and the first five segments of the pleon, so that the whole animal would probably have a total length of about

18 mm. The segments of the peraeon that are represented are very distinct, and have a depth of about 3 mm., while the greatest depth of the pleon segments, which are also pretty distinctly shown, is 5 mm. The peraeopoda are not very well preserved, but the portions of them that are present correspond with those already described for specimens 1 and 2; the three terminal joints of the 6th peraeopod are very distinctly marked, and there are portions of the 7th peraeopod extending back about as far as the third segment of the pleon, the extremity being imperfect. In the pleon the first four segments are very well preserved, showing the downward prolongation of the pleural portion very distinctly; that of the second segment reaches further downwards than the first, and is slightly narrower than the third, which is about equal to the fourth. Of the fifth only the anterior portion is present. The terminal portion of the pleon is unfortunately missing in this specimen also.

SPECIMEN 4, Fig. 4. (Block 233).

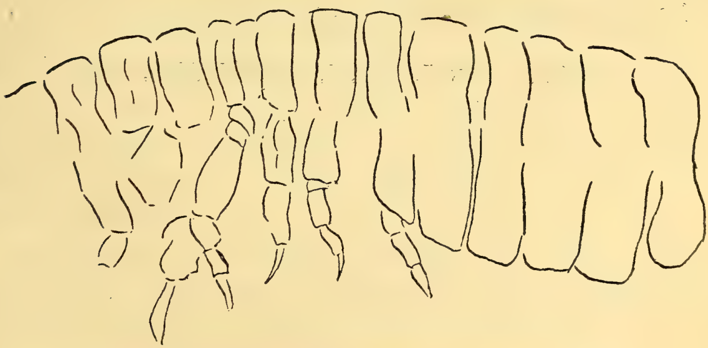


Fig. 4. *Phreatoicus wianamattensis,* (No. 233). × 5.

On this block, which is brown in colour, much paler than those bearing specimens 1, 2 and 3, the impression shows approximately the same parts as those of other specimens, that is, the posterior segments of the peraeon and the anterior segments of the pleon; but here, apparently, the

six posterior segments of the peraeon are represented, with possibly also a portion of the first. Portions of corresponding peraeopoda are present, but they are somewhat confused, and scarcely show anything additional to what has been already described in the other specimens. The broad basal joints of peraeopoda 5 and 6 are, however, distinct, and apparently these limbs had a close general resemblance to those of the living *P. australis*. As in other specimens the depth of the peraeon segments is about 3 mm., while the greatest depth of the pleon is about 5 mm.

The first five segments of the pleon are clearly indicated, especially the inferior margins of the pleural portions. The surface bearing the sixth is depressed below that of the others, and the impression on it is imperfect.

The total length of the part of the body preserved is 16 mm., and, as only the head and part of the first peraeon segment and the terminal segment of the pleon are wanting, the animal was probably about the same size as specimen 3, *i.e.*, measuring 18 or 19 mm. in length.

Specimen 5, Fig. 5. (Block 236).

Fig. 5. *Phreatoicus wianamattensis*, (No. 236*d*). × 5.

Of this specimen only the posterior portion of the peraeon is present, and that is considerably distorted, and too imperfect to add any further information; but fortunately

the whole of the pleon is present, and, although parts of it are indistinct, the conical terminal segment is clearly marked, and shows a regular projection at the posterior end as indicated in the figure. This appears to have the upper and lower sides nearly similar and evenly curved into the general outline of the segment, so that the actual projection is not marked off by a depression at its base, as in *P. australis* and others of the existing species. It appears to resemble most nearly the terminal segment of *P. tasmaniœ* G. M. Thomson and *P. spinosus* G. W. Smith; these two, however, being probably identical. The existence of this terminal segment was not observed until I had already become quite confident that the other impressions were those of a *Phreatoicus*, and the possession of this characteristic terminal portion of the pleon fully confirms the correctness of that decision.

The segments 1, 2, 3, 4 and 5 of the pleon are fairly distinctly marked so far as their inferior margins are concerned, and the general line of their dorsal surface is also clear, though the upper lateral portion of the fourth and fifth segments has been broken away. At the infero-posterior angle of the fifth segment there is an indication of an appendage which possibly represents the uropod, but this is not distinct enough to make out anything of its special structure.

The depth of the pleon segments in the specimen is about 5 mm.; the peraeon segments are hardly sufficiently marked to admit of accurate measurement.

Specimen 6, Fig. 6. (Block 236).

In this impression the posterior and dorsal portions of the pleon are absent, though the lower portions of segments 1, 2, 3 and 4 can be distinctly identified, and the whole of the peraeon and apparently the head are also present, although much confused and difficult to make out.

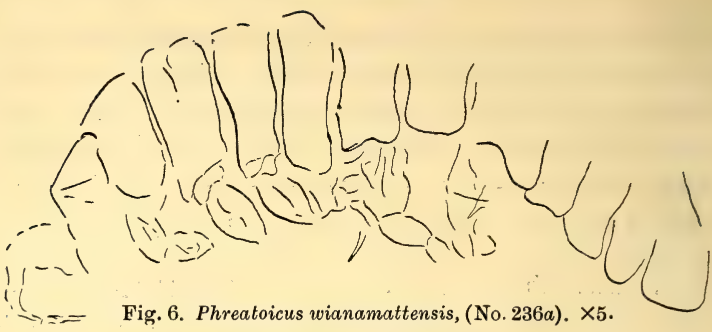


Fig. 6. *Phreatoicus wianamattensis*, (No. 236*a*). ×5.
(Counterpart of No. 235*a*.)

Of the head itself no definite structure can be ascertained, but projecting in front of it there are indications of an appendage which, in length and position, would correspond with the lower antenna, although it is too indistinct to show any details, except perhaps two or three segments of the multi-articulate flagellum.

The peraeon segments are very indistinct, but they are apparently all present; and, in the second, the inferior margin, projecting anteriorly into a subacute point, can be made out, with below it apparently the epimeron or coxal joint of the peraeopod.

SPECIMEN 7, Fig. 7. (Block 236).

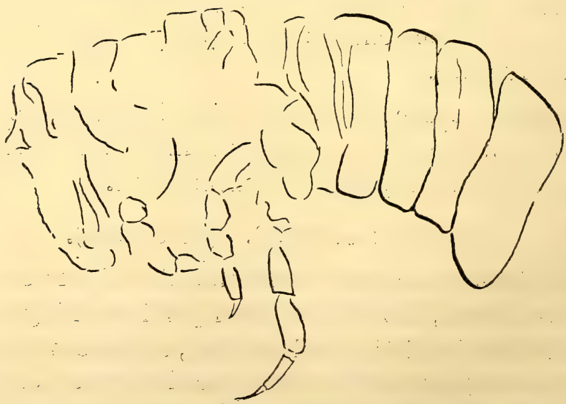


Fig. 7. *Phreatoicus wianamattensis*, (No. 236*b*). × 5.
(Counterpart of No. 235*b*.)

This specimen is also imperfect, but shows the four anterior segments of the pleon, with the same structure as in the other specimens. Two of the peraeopoda, apparently the sixth and seventh, are fairly well preserved, especially the terminal portion of the seventh, which shows the merus, carpus and propod very distinctly, and of apparently the same shape and proportions as in *P. australis*.

SPECIMENS 8 and 9, Fig. 8. (Block 239).

Fig. 8. *Phreatoicus wianamattensis*, (No. 239*a*). × 5.

These specimens are very imperfect, but show distinctly certain segments of the body, apparently the posterior segments of the peraeon, with the basal joints of the corresponding peraeopoda.

In specimen 8 (fig. 8) apparently the last four or five segments of the peraeon are represented, with indications of the first two segments of the pleon.

Specimen 9 shows two or three similar segments, but it is impossible to say which they are. They look quite like those shown in fig. 8, and I have therefore not given a figure of them.

SPECIMEN 10, Fig. 9. (Block 239).

Fig. 9. *Phreatoicus wianamattensis*, (No. 239*c*). × 5.

In this impression there is only a very small portion preserved, which by itself would be probably quite unrecognisable, but which, considered in connection with the other specimens found near it, may perhaps be taken to represent the fourth and fifth segment of the pleon, with a portion of the sixth.

[In the foregoing detailed account I have dealt with all the specimens which were first sent to me by Mr. Tillyard. After the MS. of the whole paper had been completed and forwarded to Mr. Tillyard for publication, he sent me several other specimens; and, as some of the impressions on these, especially those on Block 235, show additional points, I give a brief account of them here. I am leaving the rest of the paper in its original form, although, as will be seen, one or two of the statements with regard to the head, antennæ and uropods will require slight modification, in view of the fuller information now available with regard to them.

Block 235, which had not been sent to me at first owing to an oversight, is a particularly valuable one, as the specimens on it not only confirm the statements already made, but show additional points, especially with regard to the uropods. On it there are impressions of four specimens, with the terminal portion of a fifth, and in three out of the five the terminal segment of the pleon and the uropods are more or less distinctly marked. The following detailed descriptions will be sufficient:—

Specimen 11, Fig. 10. (Block 235).

Fig. 10. *Phreatoicus wianamattensis,* (No. 235*a*). × 5.
(Counterpart of No. 236*a*.)

This specimen shows the whole body, with the antenna fairly well marked at the anterior end, the joints of the

peduncle are indicated and the flagellum shows distinctly. Apparently all seven segments of the peraeon are present, with the basal joints of some of the peraeopods, but the head and first peraeon segment are not clear. All six segments of the pleon are represented, showing the pleural portions as in specimens already described, the terminal segment having a broadly conical point as in Specimen 5. Below it the uropods are distinctly seen, both the right and left uropods being shown owing to compression, the left apparently above the right, and there are indications of the two branches of each uropod.

SPECIMEN 12, Fig. 11. (Block 235).

Fig. 11. *Phreatoicus wianamattensis*, (No. 235*b*). × 5. (Counterpart of No. 236*b*.)

This specimen shows clearly all the segments of the pleon, including the terminal segment, which has the same shape as in the other specimens. The first pleon segment is distinct; it is not as deep as the second, and shows the shape as already described in other specimens, perhaps even more distinctly than in them. The basal joint of the uropod is also clearly seen, and there are indications of the two branches.

SPECIMEN 13, Fig. 12. (Block 235).

This specimen (near the margin of the block) shows clearly the shape of the terminal segment, and below it the peduncle and the two branches of the uropod.

Fig. 12. *Phreatoicus wianamattensis*, (No. 235*c*). × 5.

The other two specimens on this block do not add any further particulars to our information, though they are undoubtedly impressions of *Phreatoicus*, and the parts that are clear are quite similar to those described for the other specimens.

SPECIMEN 14. (Block 238).

This block shows a small specimen, 10 mm. long, with the pleon curved downwards, the only distinct part of which is the terminal segment, and below it the uropod showing basal joint and two branches, but apparently a good deal flattened.

On Block 234 there are impressions of two specimens, close together and somewhat confused. On one of them the terminal segment of the pleon with the uropods can be recognised, but the rock fracture is very uneven, and it is impossible to make out clearly any details. The other specimen situated near it shows apparently the greater part of the whole body with peraeopods, but not distinctly enough to add further details to what is already known from other specimens.

On Blocks 210 and 211 (counterpart) there are impressions which seem to represent a dorsal view, showing about 11 or 12 segments, and on one side towards the posterior end indications of the pleura of what appear to be the second and third pleon segments.]

3. Diagnosis of the Fossil Species.

It is so evident from the foregoing descriptions and figures that we are dealing with a species of *Phreatoicus* that it is unnecessary to attempt to give a reconstruction of the animal. In place of doing so, I give in Fig. 13*a*, a reproduction of the figure of *Phreatoicus australis* published in 1891 in the Records of the Australian Museum, Vol. I, pl. 23, fig. 1. In the general figure the individual joints of the peraeopoda are not quite accurately shown, and I therefore also give (fig. 13 *b* and *c*) from the same source, reproductions of the figures of peraeopoda 3 and 7. If these

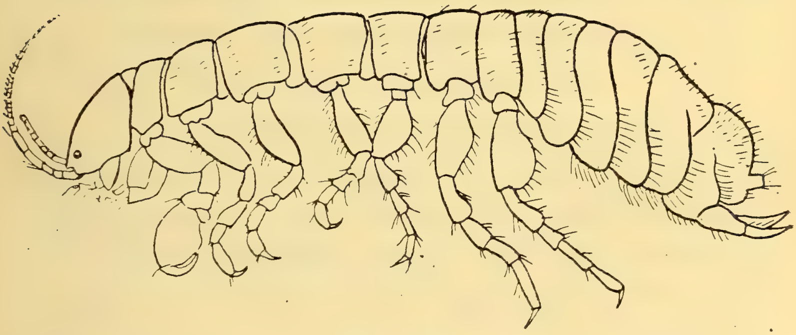


Fig. 13*a*.

Fig. 13 *b*.

Phreatoicus australis Chilton, *a*, general view, *b*, third peraeopod, *c*, seventh peraeopod.

(Copied from the original figures in Rec. Austr. Museum, Vol. I, pls. 23 and 25, *b* and *c* reduced.)

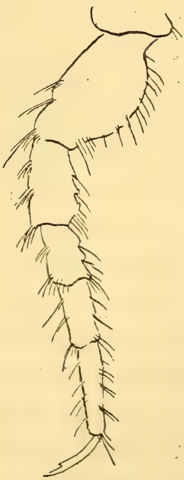


Fig. 13 *c*.

are compared with the figures of the fossil specimens given above, which have been drawn by my assistant, Miss Herriott, as accurately as possible to represent the actual impressions, it will, I think, also be evident that the fossil species comes near to *P. australis* itself, a species which again is very similar in general appearance to *P. capensis* from South Africa.

It may, therefore, be classified and described as follows:—

Order ISOPODA Latreille 1817.

Tribe or Suborder PHREATOICIDEA Stebbing 1893.

Family Phreatoicidæ Chilton 1891.

Genus *Phreatoicus* Chilton 1883.

Phreatoicus wianamattensis sp. nov.

Specific Diagnosis.—Similar in general appearance to *P. australis* Chilton. Body apparently smooth and not sculptured or tuberculated. Peraeon segments deeper than long, but not more than two-thirds the depth of the pleon. All the pleon segments with pleural portions much produced downwards, that of the first reaching further down than the last segment of the peraeon, but not so far as the second pleon segment; segments 2, 3 and 4 about subequal in length with depth gradually increasing posteriorly; fifth segment only slightly longer than the fourth; terminal segment conical in side view and ending in a subacute point with curving sides, the terminal process not being sharply defined from the general outline of the segment.

Peraeopoda similar to those of *P. australis*; (the first missing), second, third and fourth directed forwards, subequal in length, with basal joints expanded, merus produced at antero-distal angle about half-way along the carpus; the fifth, sixth and seventh directed backwards, fifth about as long as the fourth, sixth longer than the fifth, and seventh

still longer, reaching posteriorly to the hind margin of the fourth pleon segment; basal joints of all rather widely expanded, other joints longer than the corresponding ones in anterior series; merus only slightly produced at postero-distal angle.

Total length of animal up to 30 mm.

Occurrence.—Wianamatta Shale of the St. Peter's Brick-works, Newtown, Sydney, New South Wales.

Remarks.—For this species I have pleasure in adopting the specific name "*wianamattensis*" which Mr. Tillyard had assigned to it in his MS. To Mr. Tillyard belongs the credit of being the first to recognise that the fossils were the remains of a *Phreatoicus.*

While the animal in general appears to come close to *P. australis*, the terminal segment so far as it can be determined from the fossils appears to approach more nearly to that of *P. spinosus* G. W. Smith, a species from Tasmania, which is almost certainly identical with *P. tasmaniæ* G. M. Thomson. In general appearance the fossil species also comes very close to the South African species *P. capensis* Barnard.

4. Historical Account of the Phreatoicidea.

The Phreatoicidea form such a distinct and interesting group of Isopoda that it is desirable to give the following brief history of its members.

The first species, *P. typicus*, a blind one, was described by myself (1883, p. 89) from the subterranean waters of the Canterbury Plains, New Zealand. For it I established the genus *Phreatoicus*, and after discussing its relationships to several of the main groups of the Isopoda I said (1883, p. 92):

"The precise place of *Phreatoicus* in any system of classification cannot as yet be indicated with certainty, but one thing is made clear by the discussion, viz., that *Phreatoicus*, possessing as it does

affinities to several distinct groups, must be of very considerable antiquity."

This was written in 1882, though not published till 1883; I little thought then that in 1917 I should be able to describe a fossil *Phreatoicus* from the Triassic of Australia.

In 1891 I described a species, *P. australis*, with eyes, which had been obtained in surface waters at a height of nearly 6,000 feet, on Mount Kosciusko, Australia, and established the family Phreatoicidæ for the reception of the two species then known. In 1893 Stebbing placed the family in a separate tribe Phreatoicidea (1893, p. 388).

In 1894 I gave fuller descriptions of these two species, and described a third species, *P. assimilis*, also blind, from the underground waters of the Canterbury Plains. In connection with the origin of the subterranean species of *Phreatoicus*, I expressed the opinion that species would some day be found in the surface waters of New Zealand. This prophecy was fulfilled by the discovery of *P. kirkii* in 1906.

In 1894, Mr. G. M. Thomson described a species, *P. tasmaniæ*, from the Great Lake, Tasmania.

In 1896, Spencer and Hall established an allied genus, *Phreatoicopsis*, for the species, *P. terricola*, found burrowing in the banks of the upper Gellibrand River, Victoria, Australia.

In 1900, Sayce described another blind species of *Phreatoicus*, *P. shephardi*, from a spring at a height of 2,000 feet in the Plenty Ranges, Victoria; in 1916 this species was recorded from Barrington Tops (4,600 feet), New South Wales, by myself and more fully described. In the same year (1900) Sayce established another genus, *Phreatoicoides*, for the blind species, *P. gracilis*, from surface runnels, Gippsland, Victoria.

In 1902, he established another genus, *Hypsimetopus*, for a blind species, *H. intrusor*, found in the burrows of the land cray-fish, *Engœus*, in Tasmania.

In 1906, I described a species, *P. kirkii*, with variety *dunedinensis*, which though blind was found in surface streams in southern parts of New Zealand.

In 1909, G. W. Smith recorded the existence of *P. australis* from numerous localities in Tasmania, and described another species, *P. spinosus*, from the Great Lake; this, however is most probably identical with *P. tasmaniœ* G. M. Thomson. Smith drew special attention to the importance of the evidence supplied by *Phreatoicus* and other freshwater Crustacea of Australia for an Antarctic connection between New Zealand, Southern Australia and South America (1909 *a*, p. 69).

In 1914, K. H. Barnard recorded the existence of a species of the genus in freshwater streams on Table Mountain, South Africa, the species being named *P. capensis*, and after referring to the statement made by Sayce in 1902 to the effect that it would be interesting to know if any representatives were found in South America, added:—"The discovery of a species on Table Mountain, South Africa, is therefore of great interest, as being one more fact in support of the existence of an ancient land-mass connecting the southern continents (Gondwana land)" (1914, p. 233).

5. Other Fossil Isopoda.

The fossil Isopoda hitherto described are few in number, and, as Calman (1909, p. 208) says, "The little that is known of their morphology leaves their systematic position in most cases doubtful and throws no light on the phylogenetic history of the group." No palæozoic forms are known with any certainty; *Oxyuropoda ligioides* Carpenter and Swain has been described from the Devonian of Ireland

and in general shape looks like a *Ligia*, but "its appearance earlier than the primitive caridoid forms may, however, justify some suspicion as to its affinities. *Praearcturus* Woodward, from the Old Red Sandstone of Herefordshire, has very slender claims to be admitted into this order, and the same may be said of *Amphipeltis* Salter (Devonian of Nova Scotia), and *Arthropleura* Jordan (Coal Measures)."[1] Undoubted Isopoda do, however, appear in Secondary Rocks. *Cyclosphæroma* Woodward, from the Great Oolite and Purbeck and *Archæoniscus* Milne-Edwards from the English Purbeck appear to belong to the Sphæromidæ, and if so, would indicate that that family was differentiated as far back as the Jurassic Period. *Eosphæroma* Woodward from Eocene and Miocene also appears to belong to the same family. *Palæga* Woodward and *Proidotea* Racovitza and Sevastos, resembling the existing *Æga* and *Mesidotea* respectively, are known from Oligocene beds.

Urda Münster from the Jurassic of Solenhofen appears to resemble the male of *Gnathia*.

The existence of *Phreatoicus* as a fossil in the Triassic beds of Australia is therefore quite in harmony with the little that is known of the fossil Isopoda and forms a most important addition to their geological history.

6. Analogy with the Anaspidacea.

It is perhaps worth while calling attention to the fact that in Tasmania species of *Phreatoicus* are found in the same waters as the peculiar fresh-water shrimps *Anaspides tasmaniæ* and *Paranaspides lacustris*. These shrimps have been shown by Calman (1896) to be nearly related to *Palæocaris*, *Præanaspides*, etc., from the Permo-carboniferous of Europe and North America, the whole forming a group which Calman has named Syncarida. Another living

[1] Calman, in Zittel's Palæontology, Second Edition, p. 758.

member of this group, *Koonunga*, was found in fresh-water near Melbourne by Sayce in 1907, and was more fully described by him in 1908. All these forms have been fully investigated by G. W. Smith (1909 *b*), who had visited Tasmania in 1907; as yet no fossils belonging to the group have been recorded from Australia.

Anaspides, *Paranaspides* and *Koonunga* are the living representatives of a primitive and generalised group of Crustacea, the *Syncarida*, and similarly the members of the *Phreatoicidea*, a primitive group of the *Isopoda*, have continued to exist in the fresh waters of Australia, Tasmania, New Zealand and South Africa from early Secondary times.

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ACACIA SEEDLINGS, PART III.

By R. H. CAMBAGE, F.L.S.

With Plates XV to XIX.

[*Read before the Royal Society of N. S. Wales, November 7, 1917.*]

SYNOPSIS:

VITALITY OF SEED IN SEA-WATER.

LENGTH OF HYPOCOTYL.

SEQUENCE IN THE DEVELOPMENT OF LEAVES.

SIMPLY-PINNATE LEAVES.

NUMBER OF PINNÆ ON ONE LEAF.

TRIPINNATE LEAVES.

DESCRIPTIONS OF SEEDLINGS.

Vitality of Seed in Sea-water.

In previous papers on Acacia Seedlings[1] it was pointed out that seeds of *Acacia Farnesiana* had germinated after having been immersed in sea-water for 190 and 405 days respectively. In order to further test the vitality of seeds of this species, which were collected by Sir William Cullen in Central Queensland in July 1914, another seed was planted after having been in sea-water for 839 days. Previous to being planted it was placed in boiling water, and in 17 days the seedling appeared above the soil.

These experiments demonstrate the possibility of various seeds retaining their powers of germination for a sufficient length of time to be drifted many thousands of miles, provided they found suitable agents of transport.

A test was also made with seeds of *Acacia penninervis* var. *falciformis*, and *A. melanoxylon*, collected at Jenolan Caves, at an elevation of about 2,700 feet above sea-level.

[1] This Journal, Vol. XLIX, p. 94; Vol. L, p. 144.

Two of each were planted after having been immersed in sea-water for 133 days, and both of the former and one of the latter germinated in from two to three weeks, and the remaining one in eight weeks. The seeds were placed in boiling water immediately before being planted.

Although these experiments show the great vitality of certain seed in sea-water, they do not, of course, prove that the seeds secure transport. Nor does it follow that seeds of all species which are transported find suitable homes when cast ashore. It is well known that various species of different genera, in their natural state, exercise the greatest discrimination in the selection of soils and climate, and that while the seeds of many species may germinate when cast ashore, only certain species would establish themselves without having care and attention in their infancy. Bushels of seed from our typical mountain Eucalyptus species might be scattered over the black-soil plains of the west, and the great bulk of it would probably germinate, though it is most unlikely that a single tree would become established as the result.

A. Farnesiana will grow in Australia on the sea-shore or in the dry interior, and, as a result of its adaptability, is very wide-spread throughout the tropics.

Considering the marvellous distribution of the world's plants, it seems imperative, when seeking for the solution of the problem, that the investigation of all sources of natural dispersal should be exhausted before it be assumed that certain portions of such distribution may be attributed to the agency of man.

It was mentioned in Part I, (p. 24), that of four seeds of *A. Farnesiana* from Boomarra, in tropical Queensland, which were planted after having been in sea-water for three months and afterwards placed in boiling water, two immediately germinated. In Part II, (p. 145), it was

recorded that the third seed germinated after having remained in the soil for twenty-three months. The fourth seed was left in the soil and watered regularly for three years, then taken out and found to be quite hard and sound; after having been placed in boiling water it was again planted, with the result that the seedling appeared in three weeks.

Length of Hypocotyl.

The variation in the length of hypocotyl was referred to in Part I, (p. 86), when the greatest length then noticed was given as 5·5 cm. Recently a seedling was raised of *Acacia Baileyana* whose hypocotyl measured 10·5 cm.

Sequence in the Development of Leaves.

As previously pointed out, the great bulk of Acacia seedlings have only one simply-pinnate leaf and this is the first leaf on the plant, the second leaf being usually bipinnate. A few species have an opposite pair of simply-pinnate leaves. In addition to those mentioned in previous lists (Parts I and II), as having only one pinnate leaf, are the following:—

A. verticillata Willd.[1]
A. montana Benth. (with an exception).
A. Chalkeri Maiden.
A. subcœrulea Lindl.
A. subulata Bonpl.
A. cyclopis A. Cunn.
A. polybotrya Benth.

Another species which has an opposite pair of pinnate leaves is *A. crassiuscula* Wendl., (*A. pycnophylla* Benth.).

In the case of *A. montana* nine plants each produced one pinnate leaf, while one seedling had an opposite pair, so that it seems evident this species is still in something of a transition stage.

Out of about eighty species examined, only seven have constantly produced an opposite pair of simply-pinnate

[1] Also recorded by Sir John Lubbock. See Part I, p. 83 of these papers. The name should be *A. verticillata* Willd. non Sieb.

leaves. One of these is *A. myrtifolia*, in which case seeds from Sydney and Adelaide were examined (Part II, p. 157). Plants recently raised from seeds of this species, kindly forwarded to me by Professor W. G. Woolnough, from Mount Melville, Albany, Western Australia, have produced an opposite pair of pinnate leaves, thus showing an interesting constancy.

Simply-pinnate Leaves.

When speaking of simply-pinnate and bipinnate leaves in Part I of this series, it was pointed out that a simply-pinnate leaf had not so far been observed above the third leaf on an Acacia seedling, nor at all on an Acacia sucker.[1] Early this year, however, Mr. J. J. Fletcher, B.Sc., found several such leaves on specimens of *A. suaveolens* growing at Woolwich, near Sydney, and which he kindly handed to me. Others have since been found by me at La Perouse. These simply-pinnate leaves were growing in pairs, one on each side of the base of bipinnate leaves which had appeared as reversion foliage, among the phyllodes at heights up to four or five feet from the ground, and were apparently the result of some pathological trouble around the growing-point of the plants. Bipinnate leaves are common on adventitious growths of phyllodineous Acacias.

In June of this year I found one example of a simply-pinnate leaf on a sucker of *Acacia Dorothea* Maiden, at Mount Victoria, and later, several were found on suckers of this species, and of *A. obtusata* var. *Hamiltoni* Maiden, at Leura. These discoveries go to suggest that extended search may reveal more examples of both features among various species.

Number of Pinnæ on one Leaf.

In Part I, (p. 90) it was mentioned that in a few species the pinnæ increase on some of the succeeding leaves to several pairs. The remark referred to phyllodineous Acacias.

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[1] This Journal, XLIX, p. 90 (1915).

In Part II, (p. 158) *A. myrtifolia* is mentioned as sometimes having two pairs, and *A. amœna*, *linifolia* and *buxifolia* are so recorded *(infra)* in the present paper. *A. suaveolens* and *A. penninervis* var. *falciformis* may have two, *A. neriifolia*, *A. accola*, and *A. implexa* up to at least three, *A. rubida* five, and *A. melanoxylon* seven pairs. Two pairs of pinnæ have recently been noticed in West Australian examples of *A. myrtifolia*.

Tripinnate Leaves.

On one plant of *A. buxifolia* the sixth leaf had a third pinna about ·3 mm. below the terminal pair, and between this pair the excurrent point of the petiole was clearly visible before the leaf was pressed. There was no trace of even the rudiments of a pinna opposite the odd one, which was so close to the terminal pair as to make the leaf appear tripinnate. Had the petiole been produced into the rachis of the central pinna, instead of the excurrent point, the leaf would have been strictly tripinnate. (Fig. 1.)

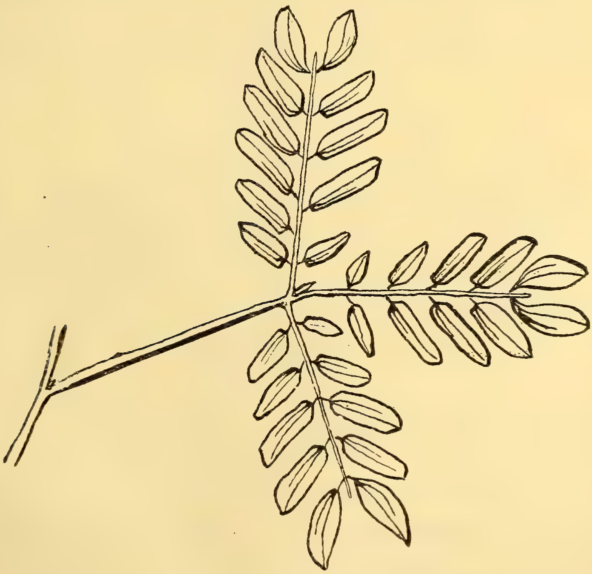

Fig. 1. *Acacia buxifolia.* Showing an apparent tripinnate leaf. × 2.

The same feature was noticed on the fourth and fifth leaves of separate seedlings of *A. spectabilis*, but here the lower pinna was 1 mm. below the terminal pair on the fourth leaf, and 3 mm. below in the case of the fifth leaf.

A similar case was found on a plant six feet high of *A. decurrens* var. *normalis*, the lower pinna being 4 mm. below the terminal pair.

On a seedling of *A. pycnantha* the fourth leaf was apparently tripinnate, but in this instance, while the excurrent point was between the central and right-hand pinnæ, it was the central and left-hand pinnæ which from their position looked like the terminal pair. The outer pair were opposite at their bases, but the left-hand pinna was the most robust of the three, and the right-hand one began to wither off as soon as it was fully developed. (Fig. 2.)

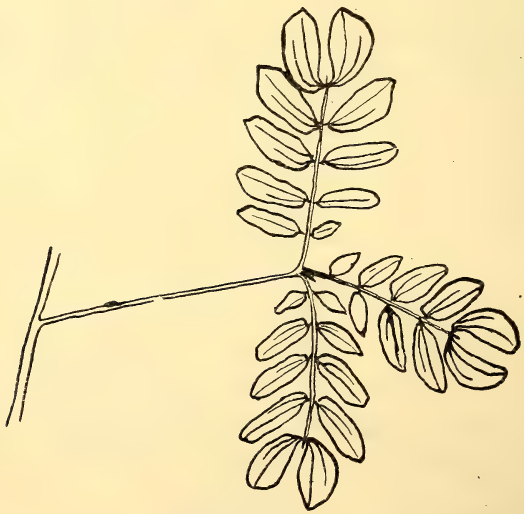

Fig. 2. *Acacia pycnantha.* Showing an apparent tripinnate leaf. ×2.

A strictly tripinnate leaf has, however, been found on a sucker of *A. Dorothea*, at Leura. In this instance there is no trace of any excurrent point at the base of the pinnæ,

and the petiole continues straight on into the rachis of the central pinna. Fig. 3.

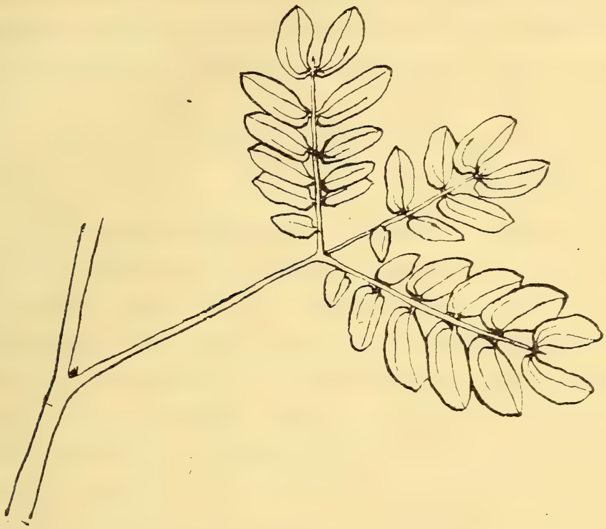

Fig. 3. *Acacia Dorothea.* Showing a strictly tripinnate leaf. × 2.

Mr. C. E. Preston records the presence of tripinnate leaves on seedlings of *Acacia leprosa.*[1]

Descriptions of Seedlings.

UNINERVES—Racemosæ.

ACACIA LEIOPHYLLA, Benth. Seeds from Botanic Gardens, Sydney, (J. H. Maiden). A Western Australian plant. (Plate XV, Numbers 1 to 4).

Seeds greyish-brown, oblong-oval, depressed along the middle on both sides, 5 to 5·5 mm. long, 2·5 mm. broad, 1 mm. thick.

Hypocotyl erect, terete, very pale green, 1·6 to 3 cm. long, 1 to 1·7 mm. thick at base, ·7 to 1 mm. at apex, glabrous.

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[1] "Peculiar Stages of Foliage in the Genus Acacia." Amer. Nat., XXXVI, p. 727 (1902).

Cotyledons sessile, auricled, oblong, apex rounded, 6 to 7 mm. long, 2 to 2·5 mm. broad, remaining erect and falling in about a week or ten days: outer or underside brown, longitudinally wrinkled, upperside pale brown, glabrous.

Stem terete, brownish-green, glabrous. First internode ·5 mm.: second 1 to 2 mm.: third 1 to 2 mm.: fourth to sixth about 2 to 3 mm.: seventh 3 mm. to 1 cm.: eighth 5 mm. to 1·2 cm.

Leaves—Nos. 1 and 2. Abruptly pinnate, forming an opposite pair, with one generally larger than the other, especially in the early stages, petiole usually slender but in one case flattened to ·5 mm. broad, and under pocket lens showing a distinct midrib with lamina on each side, the feature extending in a less degree along the rachis, from about 7 mm. to 1·1 cm. long, green, glabrous; leaflets on the larger leaf three to four pairs, lanceolate, acuminate, 4 to 5 mm. long, 1·5 mm. broad, on the smaller leaf two to three pairs, and slightly smaller, upperside green, underside paler, midrib distinct under pocket lens; rachis 5 to 7 mm. long, green, glabrous, excurrent; stipules reduced to scales.

No. 3. Bipinnate, petiole 9 mm. to 1·6 cm. long, green, slender, excurrent; leaflets three to four pairs, not always opposite; in one case the pinna was unequally pinnate; stipules flat, about 1 mm. long.

Nos. 4 to 6. Abruptly bipinnate, petiole slender, that of No. 6 sometimes showing a little vertical flattening, 1·6 to 3·2 cm. long, glabrous; leaflets four pairs, upperside green, underside sometimes brownish-red; rachis glabrous, excurrent.

Nos. 7 and 8. Abruptly bipinnate, petiole 2 to 3·5 cm. long, vertically flattened from 1 to 2 mm. broad, narrowed towards the base, with a strong nerve running along or

close to the lower margin, the lamina showing reticulating veins; leaflets four to five pairs.

No. 9. Either abruptly bipinnate similar to No. 8, or a lanceolate phyllode tapering towards the base, with a distinct midrib and nerve-like margins.

UNINERVES—Racemosæ.

ACACIA FLOCKTONIÆ, Maiden.[1] Seeds from Yerranderie, New South Wales. Growing on Permo-Carboniferous sandstone and shale soil. (Plate XV, Numbers 5 to 7.)

Seeds dull black, oval-oblong, 4 mm. long, 2·5 mm. broad, 1 mm. thick.

Hypocotyl erect, terete, very pale red, 1 to 2·5 cm. long, ·5 to 1·5 mm. thick at base, ·5 mm. thick at apex, glabrous.

Cotyledons sessile, slightly auricled, oblong, apex rounded, 4 to 5·5 mm. long, 2 to 3 mm. broad, becoming revolute, sometimes remaining until the phyllodes appear, outer or underside greenish-yellow, sometimes reddish towards apex, upper or innerside brown, becoming dark green, glabrous.

Stem terete, glabrous. First internode ·5 mm.; second 2 mm. to 1·1 cm.; third 1·6 to 1·8 cm.; fourth 1·4 to 2·7 cm.; fifth 2·6 to 3·2 cm.

Leaves—No. 1. Abruptly pinnate, petiole 3 to 5 mm. long, green, glabrous; leaflets three pairs, oblong, acuminate, 4 to 5 mm. long, 1 to 1·5 mm. broad, green on both sides, midrib showing under pocket lens, more distinct on underside; rachis 4 mm. long, green, glabrous, excurrent.

No. 2. Abruptly bipinnate, petiole 6 to 9 mm. long, green, slender, glabrous, excurrent; leaflets three pairs; rachis glabrous, excurrent.

No. 3. Abruptly bipinnate, petiole up to 1·6 cm. long, slender, glabrous, excurrent; leaflets four pairs; rachis up to 1 cm. long; stipules 1 mm. long, fragile.

[1] This Journal, XLIX, p. 476, (1915).

No. 4. Abruptly bipinnate, petiole up to 1·8 cm. long, sometimes very slightly dilated, glabrous, excurrent; leaflets up to five pairs; stipules as in No. 3.

No. 5 and upwards. Usually phyllodes with the midrib running just below the centre of the lamina.

UNINERVES—Racemosæ.

ACACIA AMŒNA, Wendl. Seeds from banks of Wollondilly River, Burragorang. (Plate XVI, Numbers 1 to 3.)

Seeds black, oblong-oval to obovate, 4 to 5 mm. long, 2 to 3 mm. broad, 1 mm. thick.

Hypocotyl erect, terete, at first creamy, becoming pink to red, 1·6 to 2 cm. long, 1·5 to 1·8 mm. thick at base, about ·7 mm. at apex, glabrous.

Cotyledons sessile, sagittate, oblong, apex rounded, 5 to 6 mm. long, 2·7 to 3 mm. broad, at first erect, becoming horizontal, revolute and cylindrical, outer or underside reddish-green to reddish, upperside pale green to brownish-green, glabrous.

Stem terete, brownish-green, glabrous. First internode ·5 mm.; second 2 mm. to 1 cm.; third 3 mm. to 2·2 cm.; fourth 3 mm. to 1·5 cm.; fifth 4 mm. to 4·1 cm.; sixth 1 to 2·3 cm.; seventh 1·2 to 38 cm.; eighth 1·2 to 2·3 cm.

Leaves—No. 1. Abruptly pinnate, petiole 3 to 6 mm. long, reddish-green, glabrous; leaflets two to three pairs, oblong, acuminate, often mucronate, 6 mm. long, 1·5 to 2·5 mm. broad, midrib just discernible on upperside, more distinct on underside, upperside greenish-red, becoming green, underside red, glabrous; rachis 4 to 6 mm. long, glabrous, excurrent; stipules flat, ovate, acuminate, 1 mm. long, with central nerve.

No. 2. Abruptly bipinnate, petiole 1·1 to 1·7 cm. long, slender, brownish-green, glabrous, excurrent; leaflets three

to four pairs, the number not being constant on each pinna of the same leaf; rachis 5 to 7 mm. long, glabrous, excurrent.

No. 3. Abruptly bipinnate, petiole 1·4 to 1·8 cm. long, sometimes channelled above, glabrous, excurrent; leaflets four pairs, upperside green, underside paler or sometimes reddish-green, the terminal pair being opposite, while the remaining leaflets are sometimes alternate; rachis glabrous, excurrent; stipules as in No. 1.

Nos. 4 and 5. Abruptly bipinnate, petiole 1·3 to 2·5 cm. long in No. 4, and 1·7 to 3·1 cm. in No. 5, about ·8 mm. broad, with a strong nerve along the lower margin, dilated above, glabrous, excurrent; leaflets five to six pairs, the basal pair usually small, the inner one the smaller, the terminal pair often obliquely obovate; rachis up to 2 cm. long, excurrent.

Nos. 6 and 7. Abruptly bipinnate, petiole 2·1 to 3·3 cm. long in No. 6, and 1·6 to 4·2 cm. in No. 7, 1 to 2 mm. broad, dilated as in Nos. 4 and 5, excurrent; leaflets six to seven pairs, up to about 1 cm. long, the basal pair often less than half that length; No. 7 may have two pairs of pinnæ; stipules about 1·5 mm. long.

Nos. 8 to 10. These may be phyllodes with a fairly central midrib and nerve-like margins, though not always with any evidence of the glands which are a feature of more mature phyllodes, or they may be abruptly bipinnate with petioles up to eight pairs.

There is no constancy in the number of bipinnate leaves which occur before the phollodes appear. In any case they are few, as compared with the numerous bipinnate leaves on a seedling of *A. rubida*, a species with which this has considerable affinity.

UNINERVES—Racemosæ.

ACACIA LINIFOLIA, Willd. Seeds from Cheltenham and Waterfall, New South Wales, growing on Hawkesbury Sandstone formation. (Plate XVII, Numbers 1 to 3.)

Seeds black, oblong-oval to obovate, edges thin, 5 to 6 mm. long, 3 mm. broad, 2 mm. thick.

Hypocotyl erect, terete, pale coloured below soil, reddish above, 1 to 5·5 cm. long, 1·5 to 2·7 mm. thick at base, ·7 to 1 mm. at apex, glabrous.

Cotyledons sessile, auricled, oblong-oval, 6 to 7 mm. long, 3·5 to 4 mm. broad, soon becoming revolute and cylindrical, falling in about two or three weeks, outer or underside pale pink, at first convex, sometimes with two or three raised longitudinal lines and a few small glands, upperside at first brownish-pink, becoming brownish-green, glabrous.

Stem terete, hirsute. First internode ·5 to 1 mm.; second 1 to 4 mm.; third 2 mm. to 1·5 cm.; fourth 2 mm. to 2·4 cm.; fifth 3 mm. to 2·5 cm.; sixth 2 mm. to 1·5 cm.; seventh 2 to 6 mm. In some of the young plants the early phyllodes become crowded, as many as thirty occurring in the length of 1 cm.

Leaves—No. 1. Abruptly pinnate, and showing beyond the edges of the cotyledons as soon as they are up, petiole 4 to 7 mm. long, green, pilose; leaflets four to seven pairs, oblong, acuminate, 4 to 7 mm. long, 1·3 to 2·6 mm. broad, the basal and terminal pairs often the smallest, the latter being sometimes obovate, upperside green, underside at first reddish, becoming pale green, midrib distinct on underside, secondary vein showing under pocket lens; rachis 1·3 to 1·7 cm. long, pilose, excurrent.

No. 2. Abruptly bipinnate, petiole 1 to 1·4 cm. long, slender, green, pilose, excurrent; leaflets five to seven pairs, oblong, acuminate; rachis 1 to 1·4 cm. long, green, pilose, excurrent.

No. 3. Abruptly bipinnate, petiole 1·2 to 1·8 cm. long, green, sometimes brownish-green, pilose to hoary, excurrent; leaflets six to ten pairs, sometimes mucronate; rachis 1·4 to 2 cm. long, green, pilose, excurrent; stipules sometimes showing as minute scales.

Nos. 4 and 5. Abruptly bipinnate, petiole up to 2 cm. long in No. 4, and 2·5 cm. in No. 5, pilose to hoary, excurrent; leaflets seven to twelve pairs in No. 4, and up to thirteen in No. 5, which, with No. 6 may sometimes have two pairs of pinnæ;[1] rachis green, pilose, excurrent.

Nos. 6 and 7. Sometimes phyllodes or they may be abruptly bipinnate, petiole up to 3·1 cm. long, pilose to hoary; leaflets up to fourteen pairs.

No. 8 and upwards. Phyllodes, varying in length from about 1 to 3 cm., ·4 to ·6 mm. broad, on plants up to 1 foot or 18 inches high.

In some cases the phyllodes are slender and weak, while on other plants they are fairly stiff, with the midrib showing under a pocket lens, and they taper into a straight or a bent point, glabrous or with a few scattered hairs towards the bases of the first dozen or so.

UNINERVES—Racemosæ.

ACACIA BUXIFOLIA, A. Cunn. Seeds from Grattai near Mudgee, (J. H. Maiden), and foot of Victoria Pass, Mount Victoria, N. S. Wales. (Plate XVII, Numbers 4 to 6).

Seeds black, oblong to oblong-oval, 4 to 5 mm. long, 3 mm. broad, 1·5 mm. thick.

Hypocotyl erect, terete, pale red, 1·7 to 3 cm. long, 1 to 2·5 mm. thick at base, ·6 to ·9 mm. at apex, glabrous.

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[1] Several examples, on natural seedlings, were handed to me by Mr. J. J. Fletcher, collected at Hunter's Hill, near Sydney.

Cotyledons sessile, slightly auricled, oblong, apex rounded, 6 mm. long, 3·5 mm. broad, soon becoming horizontal, revolute, and cylindrical, soon falling, outer or underside reddish to red, sometimes becoming pale green, inner or upperside pale red to red, becoming green, with distinct midrib.

Stem terete, except in upper portion where affected by decurrent leaf-stalks, glabrous. First internode ·5 mm.; second 2 to 6 mm.; third 2 mm. to 1·5 cm.; fourth 3 to 9 mm.; fifth 7 mm. to 1·3 cm.; sixth 5 mm. to 1·9 cm.; seventh 5 mm. to 1·4 cm.; eighth 7 mm. to 1·5 cm.

Leaves—No. 1. Abruptly pinnate, showing at a very early stage, petiole 5 to 7 mm. long, green to reddish-green, glabrous; leaflets three pairs, oblong, acuminate, the terminal pair often cuneate, about 7 mm. long, 2 mm. broad, midrib and secondary vein fairly distinct, upperside green, underside pale green or reddish; rachis 6 to 8 mm. long, glabrous, excurrent; stipules reduced to scales.

No. 2. Abruptly bipinnate, petiole slender, up to 1·5 cm. long, glabrous, excurrent; leaflets three pairs; often reddish green on both sides; rachis glabrous, excurrent.

Nos. 3 and 4. Abruptly bipinnate, petiole 7 mm. to 1·7 cm. long; leaflets three to five pairs, often mucronate, margins sometimes red; rachis glabrous, excurrent.

Nos. 5 and 6. Abruptly bipinnate, petiole 5 mm. to 1·9 cm.; terete or sometimes channelled above and showing transit to the dilated petiole, often with a small marginal gland, No. 6 being sometimes dilated above a strong nerve along the lower margin, excurrent; leaflets up to six pairs; stipules reduced to scales about 1 mm. long. No. 6 may have two pairs of pinnæ.

Nos. 7 and 8. Sometimes phyllodes, or they may be abruptly bipinnate, petiole 5 mm. to 1·5 cm. long, dilated

above the midrib to a width of 1 mm., or perhaps both above and below to a total width of about 3 mm., and with a small marginal gland, excurrent; leaflets up to six pairs.[1]

PLURINERVES—Nervosæ.

ACACIA EXCELSA, Benth., "Ironwood." Seeds from Geera, Central Queensland (H. C. Cullen), and Cobar, New South Wales (Archdeacon F. E. Haviland). (Plate XVIII, Numbers 1 to 3.)

Seeds from light to dark brown, irregularly oblong to ovate and oval, 5 to 6 mm. long, 4 mm. broad, 1 mm. thick.

Hypocotyl erect, terete, pale green to reddish, up to 2·5 cm. long, 2 mm. thick at base, 1 mm. at apex, glabrous.

Cotyledons sessile, auricled, ovate-oblong to oblong-oval; somewhat fleshy, 7 to 8 mm. long, 4·2 to 5 mm. broad, outer or underside at first pale to yellowish-green, becoming green, inner or upperside green, midrib sometimes distinct, with a few lateral veins showing under pocket lens, becoming horizontal in a few days, later folded down past the middle, often remaining until the phyllodes appear.

Stem terete, varying from green to red, glabrous. First internode ·5 mm.; second 1 to 3 mm.; third 2 to 7 mm.; fourth 3 to 8 mm.; fifth 4 mm. to 1·5 cm.

Leaves—No. 1. Abruptly pinnate, petiole 3 to 7 mm. long, reddish-green, glabrous; leaflets two pairs, 5 mm. to 1·1 cm. long, 3 to 4 mm. broad, obovate-oblong to oblong-acuminate, sometimes mucronate, midrib and secondary vein fairly distinct, sometimes distinctly triplinerved, upperside green, underside paler, petiolules often reddish; rachis 3 to 7 mm. long, green, glabrous, excurrent; stipules reduced to scales.

No. 2. Abruptly bipinnate, petiole 6 mm. to 1·5 cm. long, green, glabrous, excurrent; leaflets two to three pairs, not

[1] See reference to an apparent tripinnate leaf on this species. (*Supra*).

always opposite, oblong-acuminate to almost oval, 3 to 7 mm. long, 2 to 3 mm. broad, upperside green, underside paler; rachis 3 to 6 mm. long, green, glabrous, excurrent; stipules as in No. 1.

No. 3. Sometimes a phyllode, or abruptly bipinnate, petiole 1·4 to 2·5 cm. long, vertically flattened and with a strong nerve along or near the lower margin, with sometimes a second finer vein above, excurrent; leaflets two to three pairs, lanceolate-acuminate to obliquely obovate.

Nos. 4 and 5. These may be triplinerved, mucronate phyllodes narrowed at the base, or they may be abruptly bipinnate; petiole up to 2·4 cm. long, vertically flattened to 6 mm. broad, tapering towards the base; leaflets two to three pairs, obliquely obovate.

The first and second phyllodes are usually triplinerved with the central nerve most prominent, the third and fourth show three fairly prominent nerves with a finer vein next to, and on each side of the central and most prominent one; subsequent phyllodes often have up to seven nerves.

This is the first seedling described in this series where the No. 3 leaf has been reduced to a phyllode. In one case while No. 3 was a phyllode. No. 4 was bipinnate, though this irregularity of sequence is not confined to *A. excelsa*.

This species may develop a phyllode before the stem is half an inch high.

Julifloræ—Tetrameræ.

Acacia linearis, Sims. Seeds from Lidcombe, and Wahroonga, near Sydney. Growing on Wianamatta Shale formation, sometimes at its junction with Hawkesbury Sandstone, and usually along a moist course; also from Mosman, on Hawkesbury Sandstone formation. (Plate XIX, Numbers 1 to 3.)

Seeds glossy black, oblong, 4 mm. long, 2 mm. broad, 1 mm. thick.

Hypocotyl erect, terete, white or pale below soil, pale green to reddish above, up to 1·8 cm. long, 1·2 to 2 mm. thick at base, ·5 to ·8 mm. thick at apex, glabrous.

Cotyledons sessile, slightly auricled or sagittate, oblong, apex rounded, 6 mm. long, 2 mm. broad, outer or underside pale green, with usually one or two raised lines, inner or upperside green, glabrous, soon becoming horizontal and revolute, and sometimes remaining until the advent of the fifth leaf.

Stem terete, green, almost glabrous but with a few scattered hairs. First internode ·5 mm.; second 3 to 5 mm.; third 3 mm. to 2·4 cm.; fourth 4 mm. to 1·6 cm.; fifth 4 mm. to 1·2 cm.; sixth 3 mm. to 1·3 cm.; seventh 6 mm. to 1·5 cm.; eighth 7 mm. to 2·3 cm.

Leaves—No. 1. Abruptly pinnate, petiole 4 to 8 mm. long, green, glabrous; leaflets three pairs, rarely four, oblong, acuminate, 5 to 7 mm. long, 2·5 to 3 mm. broad, venation indistinct, upperside green, underside paler; rachis 5 to 8 mm. long, green, glabrous, excurrent.

No. 2. Abruptly bipinnate, petiole up to 2 cm. long, slender, green, glabrous, excurrent; leaflets three to four pairs; rachis up to 1 cm. long, excurrent.

No. 3. Abruptly bipinnate, petiole up to 2·5 cm. long, slender, excurrent; leaflets up to six pairs; rachis up to 2 cm. long.

No. 4. Abruptly bipinnate, petiole up to 3·2 cm. long, slightly dilated vertically, with a few scattered hairs; leaflets up to eight pairs, up to 8 mm. long, the inner ones of the basal pair usually much smaller in this and most of the leaves, (Nos. 2 to 7); rachis sometimes with a few scattered hairs; stipules 1 mm. long, flat, tapering to a point, and showing a central nerve under pocket lens.

No. 5. Abruptly bipinnate, petiole 1 to 3·7 cm. long, vertically flattened and showing midrib just below centre of lamina, with a few scattered hairs, excurrent; leaflets up to eight pairs; rachis pilose, excurrent; stipules as in No. 4.

No. 6. Abruptly bipinnate, petiole up to 4 cm. long, similar to that of No. 5; leaflets up to ten pairs; rachis pilose, excurrent.

No. 7. Abruptly bipinnate, petiole up to 5·8 cm. long, vertically flattened to 1 mm. broad, with distinct midrib just below centre of lamina, almost glabrous; leaflets up to twelve pairs; rachis with a few scattered hairs; stipules as in No. 4.

No. 8. Abruptly bipinnate, petiole up to 6·6 cm. long, with a few scattered hairs, vertically flattened to 2·5 mm. broad, with distinct midrib along centre; leaflets up to twelve pairs.

Nos. 9 and upwards. Usually phyllodes, No. 9 being sometimes up to 12·5 cm. long, while No. 13 may be 17 cm. long, and usually about 3, but sometimes 4 mm. broad, with a prominent midrib and sometimes one or two very indefinite faint nerves on each side.

JULIFLORÆ—Falcatæ.

ACACIA AULACOCARPA, A. Cunn. Seeds from Cairns (John Hill), and Biboohra (Miss L. Martin), Tropical Queensland. (Plate XVIII, Numbers 4 to 6).

Seeds glossy black, oblong to oblong-oval, 5 to 6 mm. long, 3 mm. broad, 1·5 mm. thick.

Hypocotyl erect, terete, brownish-red, 1·6 to 3 cm. long, 1·5 to 2 mm. thick at base, 1 mm. at apex, glabrous.

Cotyledons sessile, auricled, ovate-oblong to oblong-oval, 8 to 9 mm. long, 3·5 to 4 mm. broad, outer or underside

greenish-brown to pale red, smooth or with a raised line along centre on which are sometimes one or two gland-like formations, inner or upperside green, glabrous; soon becoming horizontal, and in some cases remaining until the phyllodes appear.

Stem terete and pilose in lower portion, angular above, where affected by decurrent leaf-stalks. First internode ·5 mm.; second 1 mm.; third 3 to 5 mm.; fourth 3 to 7 mm.; fifth 6 mm. to 2 cm.

Leaves—No. 1. Abruptly pinnate, petiole 3 to 6 mm. long, green, pilose, excurrent; leaflets three pairs, oblong, acuminate, often mucronate, 5 to 9 mm. long, 2 to 3 mm. broad, midrib fairly distinct, secondary vein showing under pocket lens, upperside green, underside paler, margins ciliate; rachis 6 to 7 mm. long, pilose, excurrent; stipules weak, flat at base, 1 mm. long.

No. 2. Usually bipinnate, but this species shows considerable instability in regard to the sequence of its bipinnate leaves. In one instance the second leaf was simply-pinnate with only one pair of leaflets. In several instances the second leaf developed with only one pinna, but the presence of the excurrent point of the petiole, at the base of the rachis, indicated that the leaf was not a typical simply-pinnate leaf, though no evidence could be seen of even the rudiments of the second pinna. In another leaf, each pinna had three leaflets on one side of the rachis, while those on the other side had fused into one abnormal leaflet, extending along the corresponding length of the rachis.

In normal cases the petiole is 4 to 8 mm. long, pilose to hirsute, excurrent; leaflets two to three pairs, oblong acuminate, margins ciliate, opposite leaflets often of unequal size; rachis 7 mm. to 1 cm. long, pilose, excurrent.

No. 3. Bipinnate, petiole 7 mm. to 2 cm. long, sometimes slightly dilated, with gland on upper margin, hirsute,

excurrent; leaflets two to four pairs, often irregular in size and not always strictly opposite; rachis pilose, excurrent; stipules as in No. 1.

No. 4. Sometimes a phyllode 3·5 cm. long, up to 6 mm. broad; or it may be bipinnate, with petiole up to 2·3 cm. long, vertically flattened to 2 mm. broad towards the middle, with the strong nerve or midrib along the lower margin, and a gland on upper margin, pilose, excurrent; leaflets three to six pairs, up to 8 mm. long, and 3 mm. broad, margins ciliate; rachis pilose, excurrent.

Nos. 5 to 10. Phyllodes so far as seen, falcate-lanceolate, with gland near the base of upper margin; No. 5 having one prominent nerve along centre of lamina, with numerous fine veins on both sides and nerve-like margins; No. 6 and upwards usually having two or more prominent nerves. The ashy-grey or hoary appearance so common on mature phyllodes of this species is absent from the early phyllodes, which are pale green.

EXPLANATION OF PLATES.

Plate XV.

Acacia leiophylla, Benth.

1. Cotyledons, and opposite pair of pinnate leaves, one developing in advance of the other. From Western Australia, cultivated in Botanic Gardens, Sydney, (J. H. Maiden).
2. Opposite pair of pinnate leaves and bipinnate leaves.
3. Bipinnate leaves and phyllodes.
4. Seeds.

Acacia Flocktoniæ, Maiden.

5. Cotyledons. Yarranderie.
6. Pinnate leaf, bipinnate leaves and phyllodes.
7. Pod and seeds.

Acacia leiophylla (1 to 4); *A. Flocktoniæ* (5 to 7).

Natural Size.

Acacia amœna.
Two-thirds Natural Size.

Acacia linifolia (1 to 3); *A. buxifolia* (4 to 6).

Three-fourths Natural Size.

Acacia excelsa (1 to 3); *A. aulacocarpa* (4 to 6).

Slightly under Natural Size.

Acacia linearis.

Two-thirds Natural Size.

Plate XVI.

Acacia amœna, Wendl.

1. Cotyledons. Burragorang.
2. Pinnate leaf, bipinnate leaves and phyllodes.
3. Pod and seeds.

Plate XVII.

Acacia linifolia Willd.

1. Cotyledons. Cheltenham near Sydney.
2. Pinnate leaf, bipinnate leaves and phyllodes. Nodule on root.
3. Pod and seeds.

Acacia buxifolia, A. Cunn.

4. Cotyledons. Grattai near Mudgee, (J. H. Maiden).
5. Pinnate leaf, bipinnate leaves and phyllodes.
6. Seeds.

Plate XVIII.

Acacia excelsa, Benth.

1. Cotyledons and pinnate leaf. Cobar, (Archdeacon Haviland).
2. Pinnate leaf, bipinnate leaves and phyllodes.
3. Seeds.

Acacia aulacocarpa, A. Cunn.

4. Cotyledons and pinnate leaf. Biboohra, Tropical Queensland, (Miss L. Martin).
5. Pinnate leaf, bipinnate leaves and phyllodes.
6. Pods and seeds.

Plate XIX.

Acacia linearis, Sims.

1. Cotyledons and pinnate leaf. Lidcombe.
2. Pinnate leaf, bipinnate leaves and phyllodes. Nodule on root.
3. Pod and seeds. Wahroonga.

SOME IRONBARKS OF NEW SOUTH WALES.

By R. T. BAKER, F.L.S.

With Plates XX - XXIV.

Read before the Royal Society of N. S. Wales, November 7, 1917.

THIS group of trees—the Ironbarks, is one of the best known in the Australian flora, and is especially famous for the hardness, weight, strength and durability of its timber. The number of species is rather limited, less than a dozen being so far described.

Most of the other groups of Eucalypts grade into each other, but the Ironbarks seem to be an isolated class, and so form a well defined collection of forest trees, and compared with the geographical range of the others, their distribution may be said to be rather limited, being found principally along the ranges and district of the middle portion of the east coast of the Continent.

Most of the species are well defined and their timbers very distinctive, and it is about this latter portion of the tree that this paper is more particularly concerned, for it was discoveries made in classifying the woods that gave rise to this research.

The timber of *E. crebra*, *E. siderophloia*, *E. sideroxylon*, gave no difficulty of determination, but it was not so when dealing with what was generally passed as *E. paniculata* timber.

Under what has been commonly known as *E. paniculata* it was found that several distinct timbers occur, each possessing characteristic physical properties, which bar them from being regarded as one and the same timber, especially technologically. This left no alternative but to

separate them under distinct specific names, as allowing such a variety of timbers to pass under one name would only reflect on a scientific classification, certainly on an economic one. Following up this clue it was found that the trees in addition to having distinct timbers, differed also in variation of fruits, leaves and bark.

The trouble seems to have started even from the first knowledge of this group of trees; for some of the earliest Eucalyptologists bracketed together species which now are regarded as quite distinct (*nem. con.*); thus Dr. Woolls, 1867, in a contribution to the Genus Eucalyptus, "Flora of Australia," p. 242, states:—*E. paniculata* and *E. crebra*—are mere varieties of the White Ironbark,—"I feel no hesitation in uniting *E. paniculata* and *E. crebra* as one species, although there is an occasional difference in the quality of the wood." To-day, with more data at our disposal, every systematist regards these as quite distinct, morphologically, xylologically and chemically. For the "occasional difference in the quality of the wood" we would now, from our increased knowledge, state distinct differences.

These statements necessarily do not carry too great a weight in the light of modern research,—we having greater facilities for investigation than obtained in Dr. Woolls' time. *E. crebra* has a red timber and is never known as "White Ironbark," whilst *E. paniculata* as placed systematically in the past had various coloured woods ascribed to it, and in this connection the following is of interest:—

"1. *E. paniculata*, varies in the colour of the wood from white to red, and, therefore, is sometimes called "White," and sometimes "Red Ironbark," whilst, on the Blue Mountains, the pale variety has the name of "Brush Ironbark." Although this tree appears in the interior in a stunted form, it rises in the Counties of Cumberland and Camden to the height of 120 feet, and the bark is

smoother and more uniform than that of the allied species. The wood of *E. paniculata*, especially in the pale variety, is very hard and tough, and, according to Sir Wm. Macarthur, is "the most valuable of all Ironbarks," being highly prized by wheelwrights for shafts, spokes, and cogs, or for any purposes where strength and durability are required."—(Dr. Woolls, Proc. Linn. Soc. N.S.W., 1880-1, p. 503.)

Baron von Mueller in his Eucalyptographia, under *E. paniculata*, states, that according to Dr. Woolls it is called Red Ironbark on account of its reddish dark timber, and himself states it is often darker than other kinds of ironbark timber.

Mr. Maiden, Journ. Roy. Soc. N.S.W., Vol. XLVII, 1913, "Notes on Eucalypts," p. 84, states:—

"Incidently I may say that *E. paniculata*, Sm. is referred to as Red Ironbark by Mueller in "Eucalyptographia" by a mistake on the alleged authority of the late Revd. Dr. Woolls, who, in his own copy of that work (in my possession) cancelled the word 'red' and inserted 'white.' The student of New South Wales Eucalypts knows that to the vast majority of people *E. paniculata* goes under the name of White or Grey Ironbark, while some people, noting its pink or pale red colour (sometimes deeper in tint, but never as deep a red as *E. siderophloia,)* use the name Red Ironbark, but, compared with a true Red Ironbark the term is very misleading."

Whilst cognisant of the opinions of some systematists that allowances must be made for variation in timbers of the species of this genus, yet my experience, after working on the timbers for a quarter of a century, is, that Eucalyptus timber variations are not great wherever grown, especially colour of timbers, certainly not in a range of several colours. Of course, we may find a diseased tree occasionally, but otherwise these parts and properties are very fairly constant, and that the percentage of variation is low. For instance, *E. globulus* timber is world known, and it is the

same in characters wherever grown. So with other species, for instance, *E. rostrata*, and *E. tereticornis* have wide geographical distribution, but their timbers practically always preserve specific characters, and the same remarks apply to almost every other species.

In the group of ironbarks *E. crebra* extends from the coast on and over the mountain ranges and far beyond them. The timber is always red in colour and so with *E. siderophloia*, *E. sideroxylon* and *E. melanophloia*, but as stated above, *E. paniculata*, as previously systematically placed, included, amongst other differences, four distinct timbers, and from my own knowledge of such it is difficult to admit that so wide a range of colours and qualities can exist under one species. This confusion of timbers has often called for a decision from me from merchants and others, as to whether a consignment of wood was true to name or not.

If four distinct woods are to be placed under the same species name, then it will be the exception to the rule of constancy that I have so far found to obtain in our timbers, both hard and soft.

As I think that technology especially would be better served if these timbers were specifically differentiated, it is now proposed to make the following classification, taking the white, grey or light chocolate coloured timber as the type *E. paniculata*, then apart from other characters we have remaining, a deep chocolate timber, a pink timber, and a deep red one, for which names are required, and it is now proposed to give those specific rank.

1. Eucalyptus paniculata, Sm.
(White or Grey Ironbark.)

Historical.—Mr. Maiden in his Crit. Rev. Euc. has done great service in helping to elucidate the ironbarks, especially this species, for in Vol. II, Plate 57, fig. 8 *a*, he depicts

Robert Brown's specimen, collected at Port Jackson, and although only in bud and flower yet distinctly shows it to be the White Ironbark as now generally understood, and this of course must stand as the type *E. paniculata.*

All trees with this form of inflorescence have a white or very pale coloured timber, and under the name White or Grey Ironbark are now generally accepted as typical *E. paniculata*, (Woolls and Maiden both agreeing that this is the colour of this timber) there is no alternative but to let such nomenclature stand.

Maiden states, (Jour. Roy. Soc. N.S.W., Vol. XLVII, p. 84), "*E. paniculata* is referred to by Mueller in Eucalyptographia by mistake on the alleged authority of the late Dr. Woolls, who in his own copy of that work (in my possession) cancelled the word 'red' and inserted 'white.'"

Description.—A large forest tree, with a grey or black coloured, deeply furrowed, corky, thick bark, permeated more or less with kino, except the inner portion which is very close and compact almost as hard as the wood itself. Probably it is this black coating of the bark that has given rise to the common name of "Black Ironbark" in some localities such as Port Macquarie. Leaves practically all lanceolate, the initial leaves broadly lanceolate, earlier two or three inclined to ovate, marginal vein removed from the edge, although in some cases quite close to it, venation oblique, but more marked than in the normal leaves, which have quite indistinct veins. Inflorescence paniculate. Operculum conical, either longer or shorter than the calyx, which varies from pyriform to slightly hemispherical. Fruits pyriform, urnshaped, or inclined to hemispherical, the pyriform varies in length from 3 to 4 lines and under 3 lines in diameter, slightly less in the other forms; the rim is flat, some forms have a half round ring below the outer edge and valves deeply inserted, sometimes the valves are

exserted. When the timber is white, the fruits have the raised ring at the edge.

Timber.—The colour, the first feature to be taken into account in determining this species, ranges from the very palest to a light grey or light chocolate. When first cut it is white, (and in some instances remains so), but on exposure darkens to a grey or light chocolate.

The Black Ironbark of Port Macquarie often has a number of black streaks and dark patches running through it, but otherwise it is pale. It is straight in the grain, fairly fissile for an ironbark, difficult to season, strong, heavy, compact in texture, durable and suitable for all kinds of heavy constructional and heavy carriage work.

Anatomical.—A very close compact timber, the fibres appear in a cross section to be compressed into hexagonal shapes, with thick walls, very small lumen filled with a brown deposit. The pores are fairly numerous and scattered irregularly amongst the other wood elements. The vessels are nearly all filled with tyloses; a feature of the radial and tangential sections is the numerous and distinct perforations in the fibre walls. The wood parenchyma is scarce and mostly in the neighbourhood of the vessels, the cells are nearly always filled with a brown deposit, as also are the cells of the ray parenchyma; the rays are uniformly uniseriate. A few crystals were detected.

Geographical Range.—Common along the coast district of New South Wales, also vide Mr. Maiden's localities, *(loc. cit.)*

2. Eucalyptus Fergusoni, sp. nov.

(Bloodwood-bark Ironbark.)

Description.—A tall, fine typical specimen of an Ironbark, with a facies in the field of something approaching a

"Bloodwood," from the nature of the bark, which resembles somewhat those species of Eucalypts. It is probably the thinnest bark of all the ironbarks, and lacks the deep furrows so common to the group, being friable and so very short in the fibre on the exterior half, but hard and compact and deep red in colour for the remaining thickness, there being almost an entire absence of kino. The early leaves, say two or three are at first rather broadly lanceolate, from 7 to 9 inches long and $2\frac{1}{2}$ to 3 inches broad, but later leaves much smaller and less coriaceous than the earlier ones, venation distinct, intramarginal vein removed from the edge, lateral veins medium oblique. Normal leaves lanceolate, falcate, varying in length and width, and may be described in a general way as only medium size for an ironbark, not thick; venation not at all distinct as a rule, intramarginal vein removed from the edge, lateral veins fairly oblique. Inflorescence paniculate-corymbose, but when developed into the fruiting stage becoming almost corymbose. Calyx pyriform, ribbed. Operculum conical, the rim of the calyx bulging beyond the base of it. Fruits pear shaped on a long slender pedicel, strongly four ribbed, contracted at the rather thin rim, valves deeply inserted, 9 lines long and 4 lines wide.

Timber.—The colour is a deep red or reddish chocolate when fresh cut, but rather inclined to become a lighter red when aged. It is hard, heavy, straight or interlocked in the grain, which may be described as rather open, the vessels being conspicuous in a longitudinal cut, and appearing as whitish streaks. It planes and dresses well, and is suitable for all kinds of heavy constructional works.

In its economics it is probably equal to the very best of other ironbarks, such as *E. crebra*, *E. paniculata*, *E. siderophloia*.

Anatomical.—A close textured timber with specially thick walled fibres having numerous apertures opening in

ovate, longitudinal slits, and which form a conspicuous feature in a longitudinal section. These fibres are arranged in regular radial rows of varying diameters. The vessels are numerous with or without tyloses, but mostly with, but some contain a deposit; the wood and crystal parenchyma is sparse, occurring mostly in the vicinity of the vessels, with a few scattered amongst the fibres; ray parenchyma numerous, with a reddish coloured amorphous substance in the cells, which produce the dark lines in the section given; they are nearly all one or two cells wide and a few in height.

General—It is not easy to place this species in its systematic sequence, as whilst the timber places it near *E. siderophloia*, the bark, leaves and fruits especially differentiate it from that species, as these features also do from other described species of ironbarks, *E. crebra*, *E. paniculata*, *E. sideroxylon*, *E. Caleyi*, *E. drepanophylla*.

It might be placed between *E. siderophloia* and the pink ironbark of this paper, *E. Nanglei*.

Research has shown that the timber of this tree was exhibited at the Paris International Exhibition of 1862, under the name of *E. crebra*, but later this name was changed on the specimen to *E. paniculata*.

Now that full botanical material, together with the timber specimens has been investigated and a field knowledge of the tree obtained, characters have been brought to light showing that it differs from all described species, and is here given specific rank under the name of *E. Fergusoni*, in honour of His Excellency Sir Ronald Munro Ferguson, G.C.M.G., Governor General of Australia, who has given the weight of his great forestry knowledge and experience to the furtherance and advancement of forestry in Australia.

Geographical Range.—Bulladelah and Wingello.

3. Eucalyptus Nanglei, sp. nov.

(Pink Ironbark.)

Description.—An average forest tree with a very thick, compact, deeply furrowed bark, containing large quantities of kino. Leaves lanceolate, the early-growth leaves might be described as broadly lanceolate, and of a thin texture; veins finely prominent, and not very oblique; usual leaves mostly straight, lanceolate, venation not at all prominent; lateral veins oblique, and more so than in the earlier leaves; intramarginal vein rather close to the edge. Inflorescence paniculate or axillary at the ends of the branchlets, but in the fruiting stage, the leaves having fallen, the capsules appear in quite a paniculate form. Buds under an inch long, calyx pyriform; operculum conical. Fruits inclined to pilular, constricted at the rather short pedicel or pyriform, more or less contracted at the rim, where it is more or less flat or broad; in some instances very slightly ribbed at the base or pedicel, valves not exserted, or just a little so.

Timber.—A very fine timber with a distinct clear pink or red colour, and having the facies rather of *E. rostrata*, *E. tereticornis*, or *E. propinqua*, than that of an ironbark. It may be described as close grained, heavy, hard, but does not plane to so bony a face as ironbarks, having a tendency to splinter up almost immediately after planing. It is not so heavy as other ironbarks, probably being the lightest in weight of any of them.

Anatomical.—A close textured wood made up mostly of compact thick walled fibres of varying diameters, generally running in a radial direction, the perforations being numerous but not so conspicuous as in the previous species. The vessels are fairly numerous, with bordered pits on the walls and mostly plugged with tyloses. The most conspicuous features of the wood are multiseriate bands of wood parenchyma running in the direction of the annual

rings; the ray parenchyma is mostly single or double cells wide and more cells higher than in *E. Fergusoni*, with a deposit in most of them.

General.—The timber of this tree is quite distinct from the White or Grey Ironbark of this paper, and the two could not correctly be placed under one species, especially in a public collection of timbers such as obtains in the Technological Museum. No tradesman or timber expert would pass them as one and the same wood, and it was these particular differences that influenced me to separate these trees as distinct. The bark is not so deeply furrowed nor quite so thick as in most ironbarks, but has a fair amount of kino scattered throughout its structure; the inner layer is also thinner for so large a tree. It is also easy of determination in herbarium material, and the whole plant being coarser than *E. paniculata*, and the fruits are quite characteristic, the chief feature being the rim which frequently flattens in pressed specimens.

It is difficult to trace references to this tree, but it is just possible, that, owing to its paniculate inflorescence, it may have been confounded with *E. paniculata*, and perhaps Dr. Woolls when first recording the colour of the wood of *E. paniculata* as Red may have had material of this species, vide remarks by J. H. Maiden under *E. paniculata*.

This species differs from its type *E. paniculata*, principally in the physical properties of its timbers, such as colour and texture, also in inflorescence, shape of fruits and nature of bark, and the same remarks apply to other ironbarks. In botanical sequence it may follow *E. Fergusoni*, although the organs differ considerably from that species, as well as from the other ironbarks.

This species is named after Mr. James Nangle, F.R.A.S., Superintendent of Technical Education, who was the first to introduce here the standard sizes for tested timber

specimens, and to whom I have, for many years been much indebted for his assistance in carrying out the timber tests for the Museum.

Geographical Range.—It has a wide range, preserving its specific features fairly well throughout its distribution. Localities at present known to me are Morisset, Stroud, Bulladelah, Woy Woy, Lindfield, Nowra.

4. Eucalyptus Beyeri, sp. nov.

Syn. *E. paniculata* var. *angustifolia* Woolls.

(Narrow-leaved Ironbark.)

Description.—A tree with a tall giant stem, surmounted with rather a straggling sparsely leaved head. Bark hard, heavy, very thick, permeated with kino. Leaves lanceolate throughout, those of the early stage very narrow lanceolate, thin, almost membranous, average foliage leaf wider in proportion to the length, not thick, the base tapering and evenly balanced, oblique or rounded. Venation in some cases well marked. Buds small, calyx tapering into a proportionately long and slender pedicel; operculum conical. Fruits pyriform, shining, pedicel slender, rim thin, valves attached at the base below the rim, not exserted, 3 lines long and 2 lines in diameter.

Timber.—A dark chocolate coloured timber, mostly interlocked, heavy, very hard and having a great reputation for durability; and so is one of the finest ironbarks of the country. It could be used for all kinds of heavy constructional works, such as wharves, beams, posts, bridges, heavy carriage and coach work. It is a valuable timber and not easily confounded with any other yet described.

Anatomical.—A cross section of this timber reveals an unusually large number of pores for so hard and heavy a timber, and shows a great variation in diameter. Tyloses appears to be common to most of them. The fibres are

closely packed, almost compressed, running mostly in radial lines, very thick walled, with numerous perforations, ovate in outline and at regular intervals in the long axis of this element; the lumen containing a dark deposit as well as the wood parenchyma, which is spare and scattered irregularly amongst the wood elements, and in a few cells of which crystals were detected. The rays are numerous and two cells wide and a few in height, and most of the cells contained a brown deposit.

General.—In general features such as leaves, buds, fruits it very closely resembles *E. crebra*, and from herbarium material alone might easily be mistaken for *E. crebra*, but the timber at once readily differentiates it from that species. The chief differences from the type of *E. paniculata* are the shape and size of the fruits, shape of the leaves, timber and bark. In botanical sequence it may be placed after the type *E. paniculata*.

This form was probably detected first by Dr. Woolls, for Bentham, Fl. Aus., Vol. III, p. 212, gives varietal rank to it under *E. paniculata* var. *angustifolia*, Woolls. Dr. Woolls mentions it in his article under Eucalypts, published amongst others in book form under the title of "Flora of Australia," p. 243, 1867, in these words;—"In the form angustifolia the flowers are very small." He again refers to it in Proc. Linn. Soc. N.S.W., 1880, p. 503, as only to be distinguished from *E. crebra* by having its outer stamens anantherous, although practical men easily distinguish them by their wood and bark. Maiden, in his Crit. Rev. Euc. Vol. II, records this variety, p. 104, and figures a flowering specimen, fig. 21, pl. 57.

The chief features are so distinct from the type *E. paniculata*, that it is now proposed to raise it to specific rank under the name of *E. Beyeri*, after Mr. George Beyer, who for several years was Herbarium Assistant in the

Technological Museum, and in which capacity he did much to help on the researches in economic botany, and still continues to do so in his office of chief clerk in that institution.

Geographical Range.—This tree seems rather restricted in its geographical range, being so far only recorded from Kingswood and St. Mary's, New South Wales.

EXPLANATION OF PLATES.

Plate XX.

Timbers of the species in colour.

1. *Eucalyptus Fergusoni.*
2. *Eucalyptus Nanglei.*
3. *Eucalyptus Beyeri.*
4. 4. *Eucalyptus paniculata.*

Plate XXI.

Fruits of the species.

1. *Eucalyptus Fergusoni.*
2. *Eucalyptus Nanglei.*
3. *Eucalyptus Beyeri.*
4. 4. 4. *Eucalyptus paniculata.*

Plate XXII.

1. Cross section of timber of *Eucalyptus Fergusoni.*

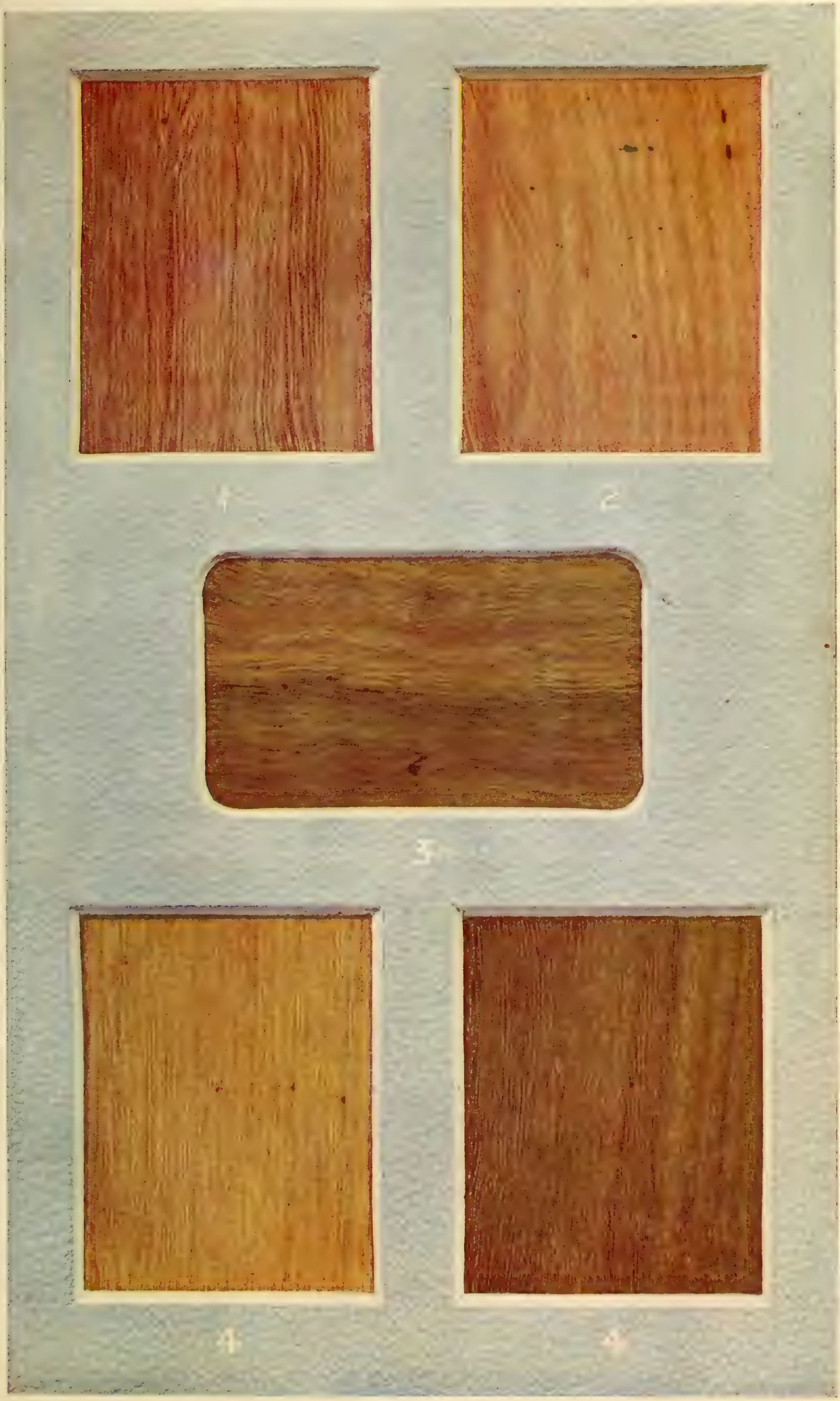
Plate XXIII.

2. Radial section of timber of *Eucalyptus Fergusoni.*

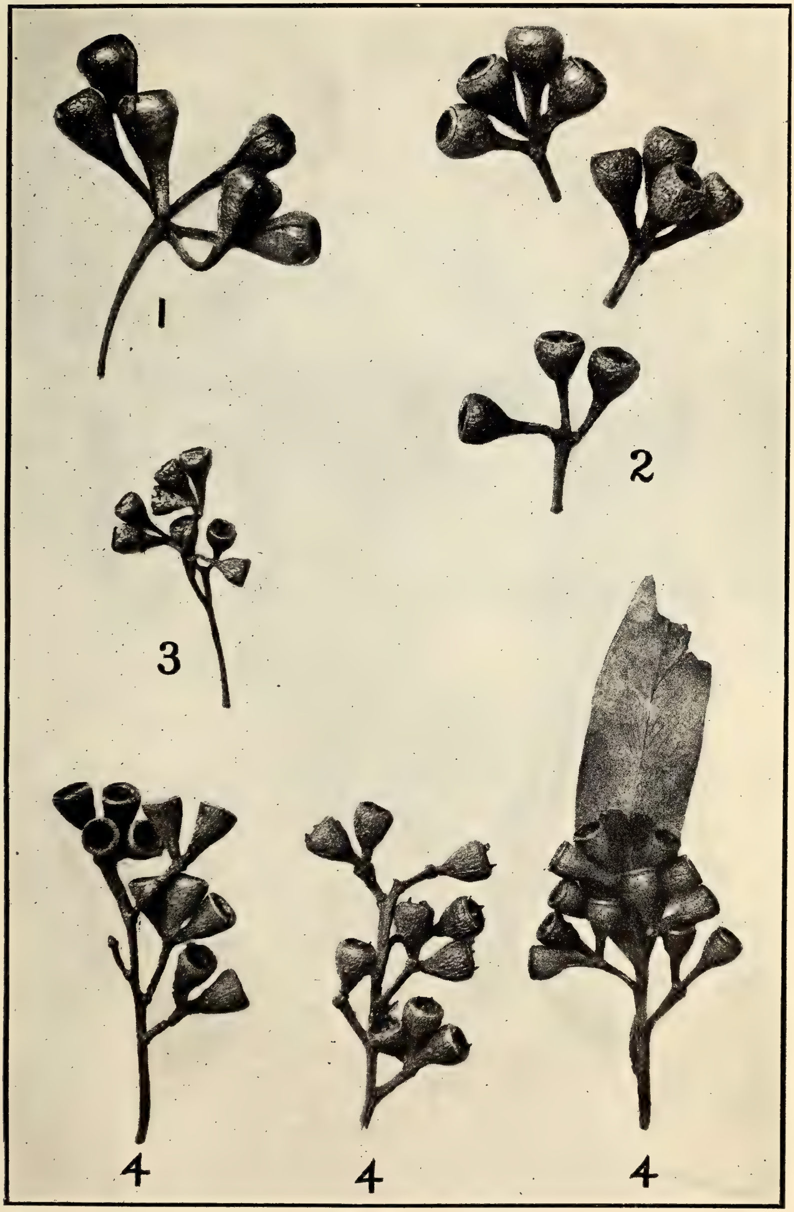
Plate XXIV.

3. Tangential section of timber of *Eucalyptus Fergusoni.*

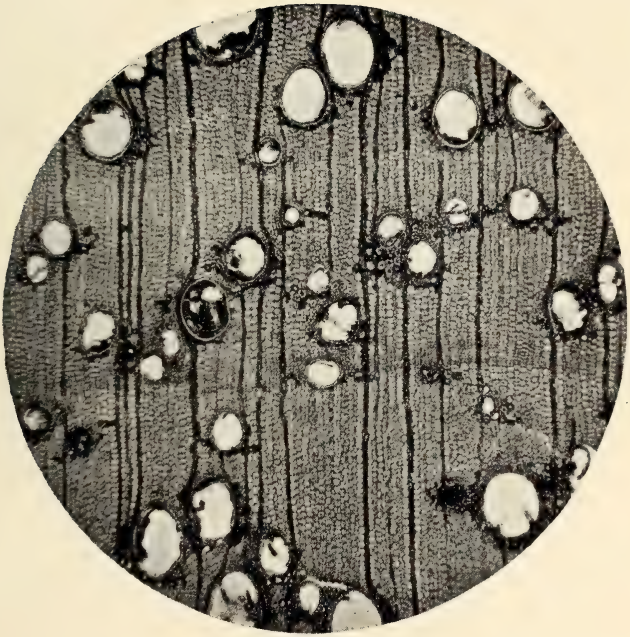
I am indebted to Mr. T. C. Roughley of the Technological Museum, for the sections and microphotographs of this paper.



COLOUR AND TEXTURE OF IRONBARK TIMBER.

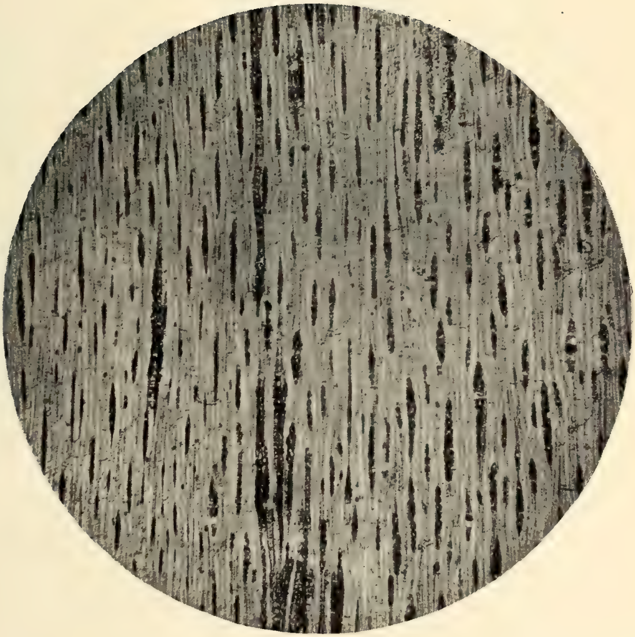


FRUITS OF SPECIES DESCRIBED IN PAPER "Some New South Wales Ironbarks."



1. *Eucalyptus Fergusoni.*—Cross section of timber showing the regular, radial, compact arrangement of the fibres; pores with varying diameters; rays with a red substance in the cells. Running across just below the centre is a portion of a ring of late wood.

2. *Eucalyptus Fergusoni.*—Radial section showing portions of numerous rays; two large vessels, and masses of fibres. At the top left hand corner is a crystal parenchyma, also at two or three other places.



3. *Eucalyptus Fergusoni.*—Tangential section showing smallness of rays, and masses of fibres; towards the left centre are crystal parenchyma. ×45.

DESCRIPTION OF TWO BORA GROUNDS OF THE KAMILAROI TRIBE.

By R. H. MATHEWS, L.S.,
Assoc. étran. Soc. d'Anthrop. de Paris.

Read before the Royal Society of N.S. Wales, November 7, 1917.

Introduction.

The large territory originally occupied by the various tribelets of the Kamilaroi community may be briefly indicated as extending from Jerry's Plains on the Hunter River, northerly as far as Walgett, Mungindi and Boggabilla on the Barwon River, taking in the basins of the Namoi and Gwydir Rivers, and also reaching a short distance beyond the Queensland boundary. Among the Kamilaroi the Bora was a great educational system for the initiation of the youths to the privileges and obligations of manhood; and at the same time to inculcate the civil and moral laws of the community. The proceedings involved were carried out at a suitable place in the bush, where the necessary clearing and marking had been done.

For some previous papers by me on subjects relating to the aborigines, see the following:—"Bora held at Gundabloui," Vol. XXVIII of this Journal (1894), pages 98 to 129. "Bora of the Kamilaroi Tribe at Tallwood," Vol. IX, N.S., (1896), Proceedings of the Royal Society of Victoria, pages 137 to 173. "Grammar and Vocabulary of the Kamilaroi Language," in the Journal of the Royal Anthropological Institute, London, Vol. XXXIII, pages 259 to 283 (1903).

The Bora Ground at Terry-hie-hie.

There is a very old Bora ground of the Kamilaroi tribes on Terry-hie-hie Station, in the Parish of the same name, County of Courallie, New South Wales, respecting which

I have gained considerable information by personal inspection. I was told by station owners and other old white men, who have resided in that district for many years, that the Bora ground referred to had been used on several different occasions by the Kamilaroi tribes throughout an extensive area of surrounding country during a long period. This is the ground referred to by Dr. John Fraser in his prize essay, "The Aborigines of New South Wales," published in this Journal in 1882, Vol. XVI, p. 216. He says, "The great ancestral Bora ground of the Kamilaroi tribe is at Terry-hie-hie." Dr. Fraser repeats this statement in another article under the same title, published by the Government Printer in 1892, p. 19.

In 1901 I made a special journey from Moree to Terry-hie-hie Station for the purpose of inspecting and reporting upon the old Bora ground above referred to. At the station I secured the services of two old Kamilaroi blackfellows, who had been present at the last bora held at this place, and who were able and willing to tell me everything I wanted to know in regard to it. As near as I could gather by enquiries, this ground had not been used for about fifteen or twenty years previously.

The main camp of the aborigines assembled on that occasion was on Terry-hie-hie Creek about three-quarters of a mile down the creek from the Terry-hie-hie Homestead. The *boora* or large ring was situated about eight chains back from the left bank of the creek mentioned, and was hidden from the view of the women and uninitiated by the intervening timber. This ring was still in a good state of preservation, and the mean of several measurements gave a diameter of 103 feet, being practically a circle. The boundary of the ring was defined by a raised bank of earth, the average height of which was 12 or 15 inches, but had probably been several inches higher when it was built and

in use. An opening about 5 feet wide was left in the western boundary of the circle, from which a path led away westerly up a gentle slope through a forest of pine trees for about eleven chains. Then a turn to left bearing W. 10° N. was made in the track, for the purpose of skirting the end of a rocky ridge, for about four chains. Another turn to the left was then made bearing W. 20° S. for about nine and a half chains, to the *goonaba* or smaller ring. At the time of my visit, there was not a vestige of the boundary of the *goonaba*. For several acres around that place the surface consisted of loose sand, and any marks made upon it would have been levelled down by the trampling of sheep and cattle for so many years.

My guides pointed out from memory the approximate position of the *goonaba*, which would have given a diameter of the circle about 50 or 60 feet. In digging into a slightly raised place on the floor of the circle, I found the remains of one of the *warrengally* or inverted stumps used in connexion with the ceremonies. It was the lower or butt part of a pine sapling, about 7 feet long, with portions of the usual spreading roots still upon it. My native guides said that at the last bora held there, the two warrengally which had been erected were pulled up and buried in the loose sandy soil, which was easily scooped out for the purpose. My guides said that the other buried stump had evidently been exposed by the trampling of stock passing over the place, and was then consumed by bush fires, which occasionally sweep through that district in dry seasons. It may be stated here that stumps of this character are mostly pulled out of their positions and burnt, as the ground is generally too hard for digging with the rude tools possessed by the aborigines. At the place in question, however, the sand was deep and afforded an easy way of disposing of the stumps, after some of the projecting roots had been broken

off. It was owing to this burying in the dry sand that the stump found by me was preserved from rotting away in so long a time.

Let us go back to the *boora* or larger ring and again start westerly along the path. Owing to the soil on each hand being very sandy, there were no traces of the usual raised earthen figures, or of the *yowan* patterns cut in the surface of the ground, all of which had been erased by the constant depasturing of stock. On nearing the end of the rocky ridge already mentioned, my guides drew my attention to a number of gum trees which had been marked with a tomahawk, but the devices had grown completely off the bark of some, whilst others were so indefinite, that I did not think them worth copying. On the end of the ridge, the loose boulders and smaller stones had been carefully gathered off the pathway, and piled either in separate heaps or around the butt of adjacent trees or stumps. This was done to make the track smooth, so that it would not hurt the feet of the men when walking along it to and from the *goonaba*.

I noticed the boles or tall stumps of several large saplings of ironbark and gum, the tops of which had been cut off at heights varying from five to eight feet from the ground—some being on one side of the path and some on the other. One of these stumps was marked in a peculiar way. It was ironbark, about nine inches in diameter, and five feet high, standing on the left side of the path, about twelve chains from the larger ring. A mortise, two feet in length and two inches and a half wide, was cut right through the bole—the lower end of the mortise being about a foot and a half from the ground. The plane of this narrow cleft through the stump was parallel to the pathway. The natives said that one of the gum trees near the track had originally contained an imitation of an eaglehawk's nest,

and another had marks as if struck by lightning. The total distance between the two circles was twenty-four and a half chains, but the pathway was not straight, as is usually the case, owing to the slight detour to skirt the rough rocky ground on the end of the ridge.

The Bora Ground at Kunopia.

A Bora was held on Kunopia Run during the latter part of 1891, for the purpose of initiating a number of young men of the Kamilaroi tribe belonging to the surrounding district. An entirely new site was selected, and the necessary preparations made near Gnoura Gnoura Creek, about two or three miles from Kunopia Homestead, in the Parish of Bonanga, County of Benarba. I did not know of this gathering till it was all over, but I visited the place during the following year for the purpose of describing the Bora ground and establishing its position on the Government maps. At Kunopia Station I found "Billy Wightman" and "Jimmy Gular," two of the principal old Kamilaroi blacks who had charge of the ceremonies in 1891, and they were very willing to give me all the assistance they could.

The natives who had assembled to participate in the ceremonies had taken up their quarters near the left bank of Gnoura Gnoura Creek, from which they obtained water for camp use. Contingents of Kamilaroi blacks came from Willarie, Moogan, Gundabloui, Mungindi and other places. Each contingent brought some youths who were ready for initiation, making a total of between twenty and twenty-five graduates, as near as I could gather from my guides.

About a quarter of a mile in a south-westerly direction from the main camp, the necessary clearing and other preparations were carried out. The *boora* or larger ring was twenty-three yards in diameter, composed by heaping the loose earth to a height of fourteen inches, with an opening

four feet wide in the western circumference. Thence a straight narrow pathway, called *thunburnga*, was carefully cleared through the forest in a westerly direction for four hundred and sixty yards to the *goonaba* or smaller circle, made in the same manner as the other. Inside the *goonaba* there had originally been the usual inverted stumps, *warrengallee*, one being box and the other sandalwood, but they had been pulled out and burnt at the conclusion of the Bora ceremonies. The path connecting the circles was formed by scraping the top surface smooth, and piling the loose soil along each side. During the ceremonies it was swept and water put on it at each end where it entered the circles —the soil being rather sandy. My native guides accompanied me all the time to explain details.

Starting along the pathway from the *boora*, at a distance of sixty yards was the imitation of an arbour or "play-house" of the bower-bird, called *weeta* in the Kamilaroi language. It was at the base of a low, small bush close to the right hand side. In the mythologic past, the *weeta* was an eminent "medicine man" among the Kamilaroi and neighbouring tribes,[1] and his bower was always represented.

At 265 yards from the *boora* was a huge male figure representing Baiamai, with his arms extended outwards, formed of loose earth heaped to the height of two feet. The length was 15 feet, and the measurement between the out-stretched hands 12 feet 3 inches. The image was lying on the back, parallel to the path, with the head towards the *goonaba*. On the other side of the path opposite to Baiamai, was his wife, Gunnanbeely, formed of loose earth heaped 1 foot 6 inches. The length of the body was 10 feet and the width between the extended hands 8 feet. She was also lying on the back, but instead of being parallel to the

[1] See my "Ethnological Notes on the Australian Aborigines," (Sydney, 1905), pp. 179 – 181.

path like her consort, her body was at right angles to it, with her feet towards the path. All the usual *yowan* patterns and other devices imprinted on the turf, had been obliterated by rain and dust storms. My guides said they commenced at the *weeta's* arbour and extended close to the *goonaba*.

About 25 yards beyond the two human figures was the *goomee*, or heap of earth, on top of which Baiamai's fire was kept burning. Between Baiamai's fire and the *goonaba*, on the right hand side of the path, was a box tree, in which an imitation of an eagle-hawk's nest was built by the natives. Steps were cut in the bark up to the nest, to illustrate the Kamilaroi legend of climbing up to kill the eagles and their young ones.[1]

At another place, on the left of the path, was a box tree about 50 feet high, with a spiral line cut in the bark round and round the bole from the ground up to a height of about 30 feet, to represent a tree struck by lightning. A pole 19 feet long was laid horizontally through a fork of this tree, with a small bark *koolamin* at each end to provide water for Baiamai's use during the ceremonies. This pole had a spiral line cut in its bark the same as the tree, and was supposed to have been carried there by the lightning. Sometimes only one end of the pole has a koolamin for water attached to it, while the other end is split as if shattered by the lightning when placing it there.

A box tree on the right of the path had a snake 4 feet 6 inches cut into the bark; and at another place on the left was a box tree with an iguana 6 feet long cut upon it.

I copied fourteen of the marked trees—eight growing on the right and six on the left of the pathway, but those

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[1] See my "Folk-Lore of the Australian Aborigines," (Sydney, 1899), pp. 11–14.

above described are the most important. Trees showing an eagle's nest, marks of lightning, a snake, and an iguana are usually found on all Kamilaroi bora grounds.

From enquiries made at the Police Station at Kunopia I learnt that the total number of natives of both sexes and all ages, who had assembled at the camp on Gnoura Gnoura Creek was about 250.

In an article entitled "Ground and Tree Drawings," with plate, I illustrated a large number of drawings by the aborigines in different parts of New South Wales. In that plate, figs. 18 and 19 portray the colossal images of Baiamai and Gunnanbeely mentioned in the present paper; and figs. 7 to 16 show the markings on ten out of the fourteen trees referred to.[1]

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[1] American Anthropologist, Vol. IX, (1896), pp. 38, 44 and 45.

NOTE ON THE GREAT AUSTRALIAN ARTESIAN BASIN.

By E. F. PITTMAN, A.R.S.M.

[*Read before the Royal Society of N. S. Wales, November 7, 1917.*]

[See paper by Dr. A. L. DU TOIT, *supra* p. 135.]

I desire to briefly allude to several instances in which Dr. du Toit, in his paper on "The Problem of the Great Australian Artesian Basin,"[1] has quoted from my writings, and in which he has drawn misleading or inaccurate deductions therefrom.

1. In his introduction to his paper he makes the following remarks:—

"Against such views (Professor Gregory's views.—E.F.P.). Mr. Pittman, the most uncompromising protagonist of the meteoric theory, vigorously protested, claiming that all other geologists in Australia were at one with him in favour of a purely meteoric derivation of the water in the Great Basin. When in Australia in 1914 the author found that, so far from this being the case, quite a number of the local geologists were perfectly ready to admit that many aspects of the problem could better be explained by the rival hypothesis."

The actual statement made by me in reference to this matter was as follows:—

"The unanimous opinion of those geologists *who have had opportunities for a careful study of the Great Australian Artesian Basin* is that the water which comes from the flowing wells is of meteoric origin, and that hydraulic pressure is the primary cause of its rising above the surface in bores. Amongst those who hold these views are the Government Geologists of Queensland, New South

[1] This Journal, LI, p. 135 (1917).

Wales, South Australia and West Australia, all of whom have made a careful study of the subject in the field."[1]

2. Under the heading "V. The Salinity of the Waters," Dr. du Toit states:—

"Gregory has laid stress upon the presence of small amounts of boric acid in quite a large proportion of the New South Wales waters, and this substance is probably more widely spread, only it has not been looked for. He has regarded this radicle as pointing towards a magmatic origin for the water, *and certainly Pittman's contention (that its presence is not peculiar, because borates would be contained in salts derived from sea water by evaporation) is ineffective, because the Jurassic beds are admittedly of freshwater origin.*"

Anyone reading the above passage would be justified in concluding that I had overlooked the fact that the Jurassic beds were not of marine origin, but Dr. du Toit has completely ignored the following paragraph in my paper:—

"The fact that the water-bearing beds of the Great Australian Artesian Basin are everywhere overlain by the *marine beds of the Rolling Downs Formation* suggests a very much simpler, and a very much more probable source for the "trace" of boric acid in the water than the one advanced by Professor Gregory. In all probability a similar trace of boric acid would be found, if carefully looked for, in almost any water which percolates Mesozoic or Tertiary rocks of marine origin."[2]

3. Under the heading "VII. The absorption and transmission of water," Dr. du Toit makes the following remark:

"Pittman having admitted Gregory's contention that the Blythesdale Braystones will not be porous enough to transmit large enough volumes of water underground, it now remains to

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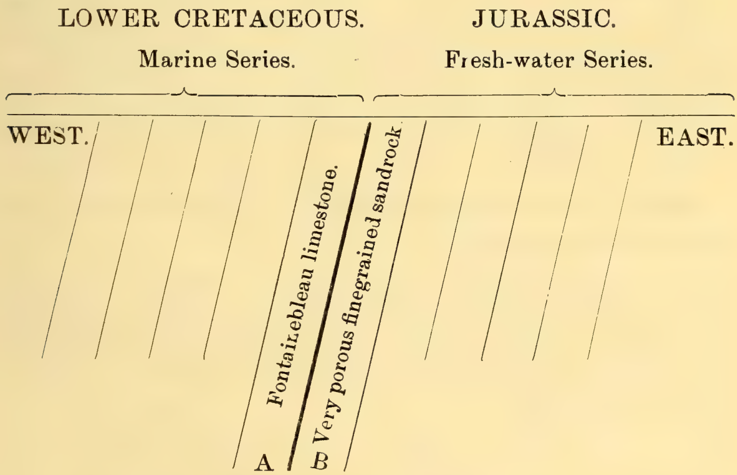
[1] E. F. Pittman, "The Great Australian Artesian Basin and the source of its Water," 1914, p. 39.

[2] E. F. Pittman, "The Constitution and Porosity of the Intake Beds of the Great Australian Artesian Basin," 1915, p. 10.

submit the Jurassic sandstones to a critical examination as to their capabilities in this direction."

Dr. du Toit is completely mistaken, as no such "admission" was ever made by me.

The term Blythesdale Braystone was first adopted by Dr. R. L. Jack, who described it (in 1895) as a very porous marine sandstone forming the lowest bed of the Lower Cretaceous Series (Rolling Downs Formation). But it has recently been made clear that the lowest bed (A) of the Lower Cretaceous Series has none of the characteristics of a braystone, but is a Fontainebleau limestone, while the uppermost bed (B) of the Jurassic Series is a freshwater, and not a marine sandstone.



The question, therefore, arises as to which rock, A or B, Dr. R. L. Jack intended to designate by the name "Blythesdale Braystone"? I have no doubt whatever that it was B, because in the Geological Survey Office in Brisbane, in the year 1896, I was shown some hand specimens of the so-called Blythesdale Braystone, and they were similar in lithological character to the rock forming the bed B. But,

as stated above, this rock is a freshwater and not a marine sandstone, and it belongs to the Jurassic and not to the Lower Cretaceous Series.

In my earlier papers on artesian water I accepted as correct Dr. Jack's description of the character and position of the Blythesdale Braystone, and stated that it was not known to outcrop in the State of New South Wales. Subsequently, however, I had an opportunity of examining the section between Blyth Creek and Roma, and it became evident that the name had been adopted under misapprehension, both in regard to the origin and the geological horizon of the rock, and in 1914 I published a statement to that effect,[1] and added that, so far as it referred to the lowest bed of the Lower Cretaceous Series, the term "Blythesdale Braystone" was a misnomer. Again in 1915 I suggested[2] that the name should be abandoned, as its continued use could serve no good purpose, but could only lead to confusion.

That it has led to confusion in Dr. du Toit's case is very evident in his paper.

In my latest papers it was stated that *the lowest bed of the Lower Cretaceous Series is not particularly porous*, but that bed was certainly not referred to as the "Blythesdale Braystones."

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[1] E. F. Pittman, "The Great Australian Artesian Basin and the source of its water," 1914, p. 13.

[2] E. F. Pittman, "The composition and porosity of the intake beds of the Great Australian Artesian Basin," p. 11.

ON THE OCCURRENCE OF CRYSTALS IN SOME AUSTRALIAN TIMBERS.

By R. T. BAKER, F.L.S.

[With Plates XXV - XXXIII.]

[*Read before the Royal Society of N. S. Wales, December 5, 1917.*]

WHEN examining micro-sections of our timbers it was noticed that crystals occurred rather frequently amongst the wood elements. In certain species they were either isolated or varied in number from a few to as many as over forty in an individual parenchyma, and even masses of deposits in particular cases.

Searching through publications at my disposal, no mention could be found of this feature amongst Australian woods, either in letter press or illustrations, and so I am moved to record the specific instances of such occurrences which have come under my notice.

Amongst works on timbers, S. J. Record, in his "Economic Woods of U.S.A.," p. 20, states, that crystals occur in all species of Quercus, though they are more commonly abundant in live Oaks (evergreen) than in deciduous species. In Juglans (Walnut), Hicoria, and Diospyros, crystals are often quite conspicuous. He also gives micro-photographs of timber *Hicoria pecan* and *Diospyros virginiana* showing crystals *in situ*, but in the latter instance not easy to detect, and these were determined as calcium-oxalate. He also mentions that these crystals are only slightly soluble in the strongest acids.

Henry Kraemer, in his "Applied and Economic Botany" 1914, p. 187, figures crystals (diagrammatic) identical in form to those found by me in Australian woods, but they are from the bark of Glycyrrhiza.

Mr. H. G. Smith has recorded[1] calcium oxalate from the bark of various Eucalypts, (10 species), obtained by breaking the bark down, boiling and then recovering the crystals.

A very large number of instances of the occurrence of calcium oxalate crystals in the vegetable kingdom are given by Solereder in his "Systematic Anatomy of Dicotyledons," but the majority of these instances are in the leaves, bark and root.

In the case of the leaves he almost invariably states that this substance in its various crystalline forms is excreted, meaning of course in the process of metabolism. But in my opinion the word "deposited" would more correctly describe the action, in any case at least in the secondary wood if not the leaves. Again, this fixation of lime by the oxalic acid seems to prove in the opinion of the author that the latter is not deleterious to the plant any more than manganese, but is specially formed by the tree for this particular function, in order to free the sulphur from the calcium sulphate for the formation of sulphuric acid so essential in the construction of albuminous substances.

Various authors record that oxalate of lime is found in several forms, viz.:—as ordinary solitary crystals, clustered crystals, styloid-like crystals, raphides, small circular crystals, and crystal sand.

From the result of this investigation it would appear, that each of the above is restricted to a particular organ of the plant, such as leaves, bark, root and timber, but in the case of the latter only ordinary solitary crystals were found, which seems to prove that this is the usual form for wood structure.

In the timbers examined to illustrate this paper, the crystals were so numerous that sufficient definition was

[1] This Society, 1905, Vol. xxxix, pp. 23 to 32.

obtained which made it possible to determine the crystalline system without any breaking down of the wood or any preparation whatever, viz. plates or prisms of the monoclinic forms.

They occur with few exceptions in a specialised form of chambered wood parenchyma, with partitions dividing it into cells of about equal size containing as a rule an individual crystal, but, in one case of ray parenchyma, as many as four were found in a cell, viz :—*Mallotus philippinensis*, Natural Order Euphorbiaceæ.

The micro-sections of timber were prepared by long immersion in strong hydrofluoric acid, which, however, appears to have had no effect upon these crystals of calcium oxalate, and this insolubility is no doubt further aided by the protective property of the cell walls.

In the case of *Strychnos arborea*, N.O. Loganiaceæ, however, they were found in long pockets in great abundance, giving the wood the appearance of having been marked with chalk streaks on a longitudinal section, or as distinct white spots on a cross section, as shown in Plates XXX, XXXI. The hydrofluoric acid, however, appears to have had some effect on this material, or at least the greater part was lost in the slide preparation. It is possible, however, that the diameter of these sacs or pockets being so large the substance fell away. Plate XXX shows this substance *in situ* with numerous crystals amongst the matrix. I am indebted to Mr. J. H. Maiden for this particular specimen of timber upon which the research was made.

It is common amongst artisans to speak of a particular wood as "having a grit," two Australian woods being notorious for this special physical property, viz :—*Eucalyptus pilularis*, "Blackbutt," and *Tristania conferta*, "Brush Box." An examination of these showed them to be more or less permeated in the vessels with silica rather than with this substance.

Solereder mentions that in some instances a certain form of crystal is characteristic of an entire Natural Order, yet in other cases it serves to distinguish only genera and species, but so far as my investigations have gone, this does not seem to obtain in Australian woods, for a uniformity appears to hold throughout, the variation being only in size and number.

In order to give some idea of the character of the wood in which these crystals occur, a short anatomical description of the texture of each species is given.

Twenty-two (22) orders were examined, and of these, crystals were found to occur in the secondary wood of (15) viz:—

Pittosporeæ.	Sterculiaceæ.	Rutaceæ.	Olacineæ.
Meliaceæ.	Rhamneæ.	Sapindaceæ.	Anarcardiaceæ.
Leguminosæ.	Saxifrageæ.	Myrtaceæ.	Ebenaceæ.
Loganiaceæ.	Euphorbiaceæ.	Casuarineæ.	

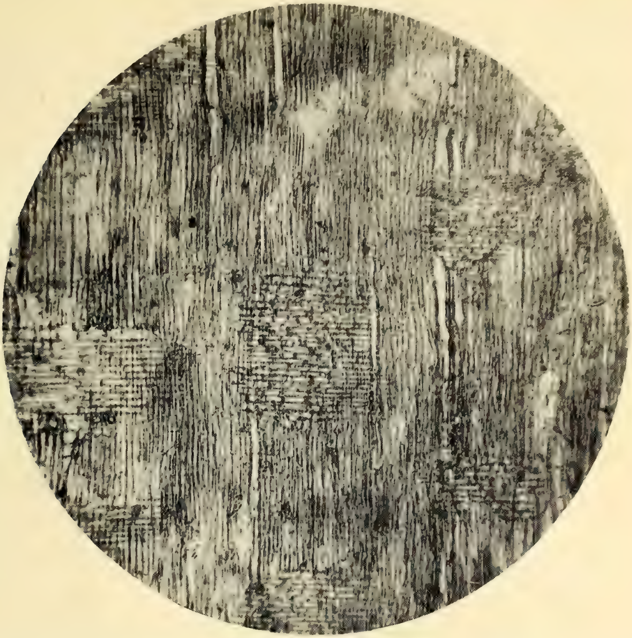
List of Species in which Crystals are found:—

1. Pittosporum undulatum, Vent. N.O. Pittosporeæ.

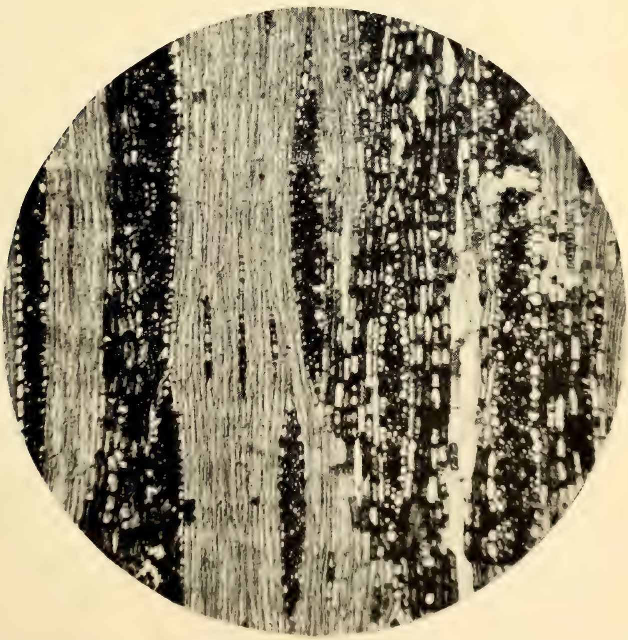
The pores have a comparatively small diameter, and the wood parenchyma is very limited. The rays are of the heterogeneous type and have fairly thick walls; the unusually large wall markings of the vessels are a distinct feature of this species. The fibres are numerous, with few exceedingly minute wall perforations. A crystalline deposit of monoclinic crystals, plates or short prisms,—calcium oxalate, was seen in some of the cells of the ray parenchyma which have very delicate walls, otherwise the wood elements were free of any deposit.

2. Tarrietia argyrodendron, Benth. N.O. Sterculiaceæ.

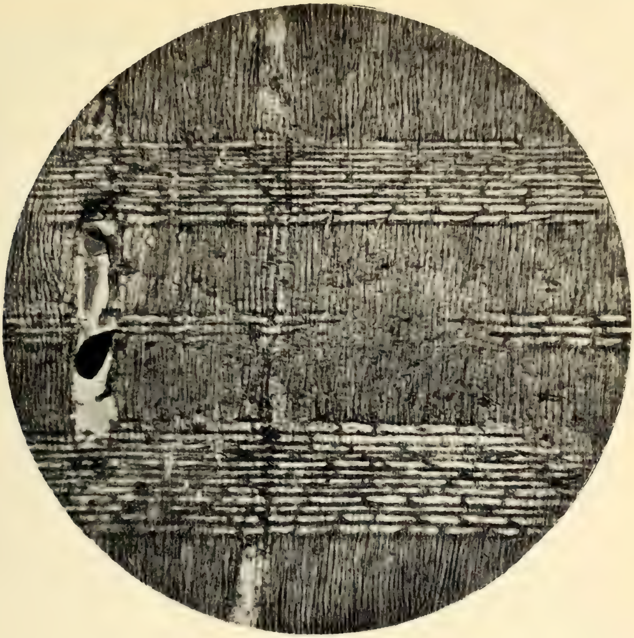
The two main characteristics of the anatomy of this timber are the disposition of the wood parenchyma and the presence of a brown deposit in its cells as well as that of



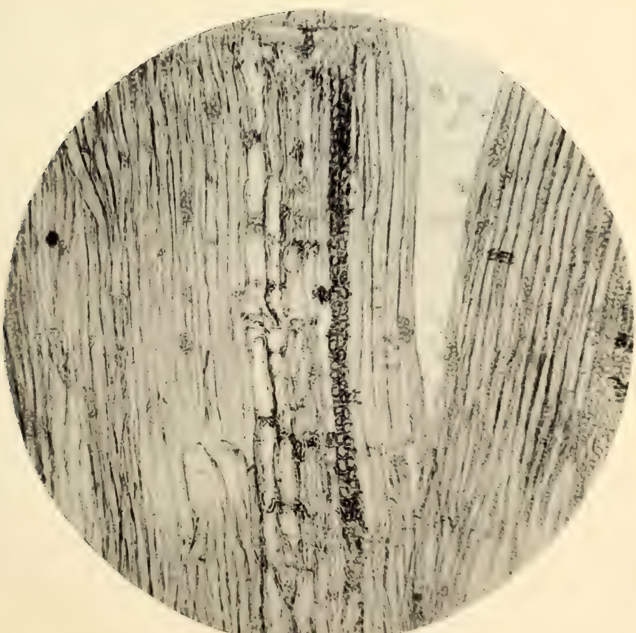
Pittosporum undulatum.—Radial section showing crystals in ray cells on the extreme left. × 45.



Tarrietia argyrodendron.—Tangential section showing crystals at the top and extreme right. ×45.



Flindersia australis.—Radial section shewing vertical view of crystals in middle of top ray, and other places. ×45.



Flindersia australis.—Radial section showing a conjugate crystal parenchyma with a calcium oxalate crystal in each cell; to the left, wood parenchyma, the remainder fibres. ×100.

the rays. It is not unlike some of the *Grevilleas* and *Orites excelsa* in having fibres and parenchyma arranged in alternating concentric bands. The fibres are thick-walled leaving very little space for the lumen, and perforations appear to be almost entirely absent. The vessels are rather large and mostly clear of tyloses, and around them wood parenchyma occurs as well as in the position stated above. The predominating rays belong to the multiseriate class, and in a radial section are seen to be heterogeneous, the outer row of cells containing monoclinic crystals, plates, or short prisms of calcium oxalate.

3. Bosistoa euodiformis, F.v.M. N.O. Rutaceæ.

A pale coloured, hard, close grained timber, which in a cross section shows the fibres arranged in bands alternating with wood parenchyma,—amongst which is found a special form containing simple monoclinic crystals in the individual cells. They are quite absent from the ray parenchyma.

4. Villaresia (Chariessa) Moorei, Ruiz. N.O. Olacineæ.

The features of this wood are quite specific in a transverse section, for the fibres appear to stand alone, being separated by compressed wood parenchyma, or a continuation of the walls of the latter or surrounded by them. The fibre walls are very thick, leaving a very small lumen, the wall perforations being very numerous and run in the long axis. The vessels are numerous and rather free from tyloses, but show some very fine examples of scalariform apertures. The rays are mostly free from the ordinary deposit, but a fair number of crystals were detected; the multiseriate kind of ray predominates, which is occasionally bounded by tracheid cells.

5. Flindersia australis, R.Br. N.O. Meliaceæ.

An exceedingly close-textured wood, the very numerous fibres having thick walls, leaving only a small space for the

lumen, the wall apertures being very few and very small, ovate and longitudinal. The pores are not numerous, the wood parenchyma running in lines between the solid mass of fibres, and also around them. A few crystal wood parenchyma were present. The vessels have very numerous wall-pits, the partition walls of the cells belong to the scalariform variety; some contain a brown deposit. The rays are fairly numerous, varying from uniseriate to three and four cells wide and several cells high.

6. Emmenospermum alphitonioides, F.v.M.
N.O. Rhamneæ.

This is not so uniformly structured as its congener *Alphitonia excelsa.* The fibres are arranged in regular radial rows, but of varying diameters, and have only a medium thickness of wall, giving a comparatively large lumen, the wall perforations being few. The vessels are fairly numerous, but often two or three conjugate, the walls being strong and full of perforations, but free from tyloses. The wood parenchyma is exceptionally sparse, whilst the rays are numerous and from one to several cells wide and also in height; a few crystals were seen in the latter.

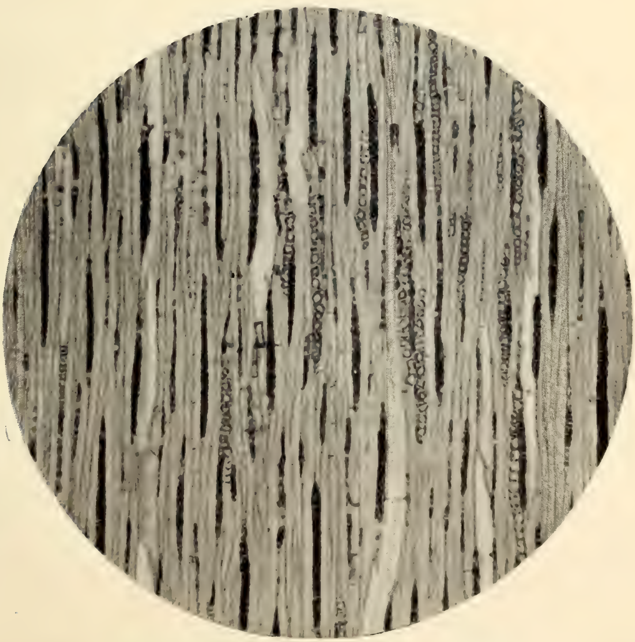
7. Ratonia tenax, Benth. N.O. Sapindaceæ.

This wood is of a uniform texture, the fibres being of equal diameter, with walls of medium thickness, thus leaving a fair sized lumen; the numerous wall perforations running with the long axis of the fibres. The vessels are rather small, but fairly numerous and scattered irregularly throughout the other wood elements, and with an absence of tyloses. The wood parenchyma is more limited than that of most timber examined, and the few seen had their cells filled with crystals. The ray parenchyma had in almost every instance a deposit in the narrow horizontal cells; vertical cells border these top and bottom. They

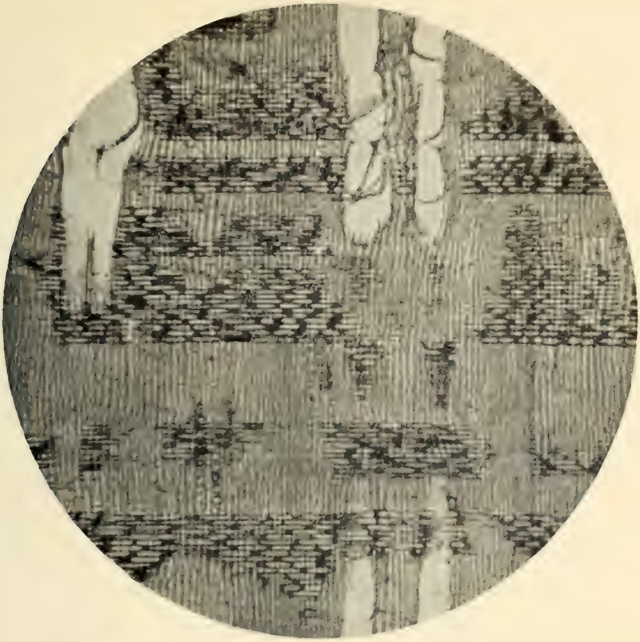
Acacia pendula.—Tangential section showing numerous wood parenchyma with crystals. ×45.

Acacia pendula.—Tangential section, with two highly magnified wood parenchyma, with calcium oxalate crystals. ×200.

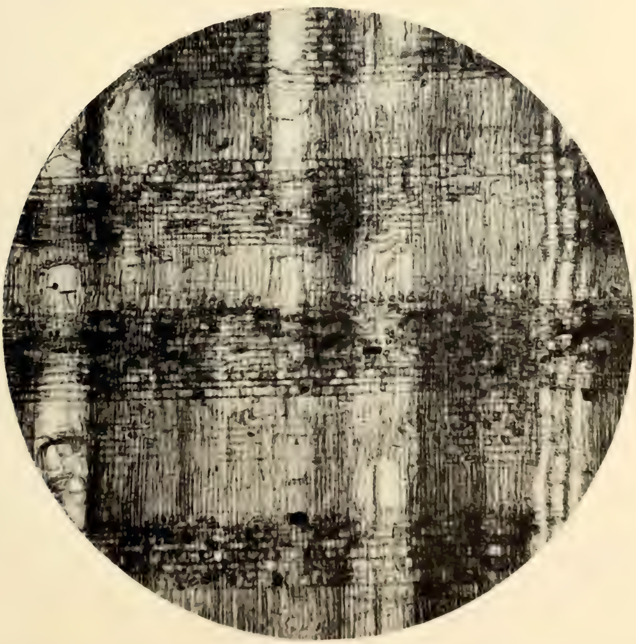
Weinmannia lachnocarpa.—Radial section showing several wood parenchyma containing crystals. ×45.



Weinmannia lachnocarpa.—Tangential section showing wood parenchyma containing calcium oxalate crystals. ×45.



Ratonia tenax.—Radial section; a crystal parenchyma is seen just below the centre and low left from that. ×45.



Rhodosphæra rhodanthema.—Radial section showing rays with numerous crystals in the cells. ×45.

were, almost without exception, of the uniseriate form and a few cells high.

8. RHODOSPHÆRA RHODANTHEMA, F.v.M.
N.O. Anacardiaceæ.

A very regularly constructed timber, the fibres running in radial rows parallel to the rays, having walls of medium thickness with a lumen a third the diameter of this wood element, the perforations were not distinctly discernible. The only instance seen of septate fibres of the species microsectioned. Parenchyma of the wood rare, but the rays numerous, and these are especially interesting as nearly all the cells contain the monoclinic crystals of calcium oxalate, and in no other instance were they found to be so numerous in the rays, except perhaps in *Mallotus philippinensis.* The vessels have rather thin walls—the chief feature of these organs is the polygonal figures surrounding the pits.

9. ACACIA PENDULA, A. Cunn. N.O. Leguminosæ.

A very dark almost black coloured timber, a feature due very largely to the dark deposit in almost all the wood elements. The vessels are large with thick walls and a dark coloured deposit apparently of a similar nature to that found in the fibres and certain wood parenchyma and the rays. The wood parenchyma is very numerous and is either clustered around the pores or running in lines amongst the early and late growth, and in the majority of cases the cells are filled with calcium oxalate crystals, in fact they are more numerous in the wood parenchyma of this timber than any other examined. In the rays the cells are filled with a substance similar to that of the vessels.

10. WEINMANNIA LACHNOCARPA, F.v.M. N.O. Saxifrageæ.

The most characteristic sections in this connection are the tangential and radial, the crystals being seen clearly in

both, especially the former, as shown in the illustration. The wood parenchyma, which is exceedingly narrow, except where the crystals occur, runs in single rows between the rays separating two, three or more rows of thick-walled fibres rather devoid of wall perforations and a very limited lumen. The rays are multiseriate mostly, and filled with a secretion similar to the narrow wood parenchyma cells. The vessels are narrow with well-marked wall perforations; no tyloses were detected.

11. Eucalyptus albens, Miq. N.O. Myrtaceæ.

In a transverse section the pores seem to be most numerous, disposed in rings alternating with solid rings of fibres, the rays being very fine and numerous, wood parenchyma is sparse, but mostly the cells contain crystals; the vessels are nearly all plugged with tyloses, and the fibres forming the bulk of the timber are very compact with a very narrow lumen, and pits running longitudinally, the borders showing better in the tangential wall. It is this predominence of fibres that, no doubt, adds so considerably to the weight of the timber.

12. Eucalyptus Dawsoni, R.T.B. N.O. Myrtaceæ.

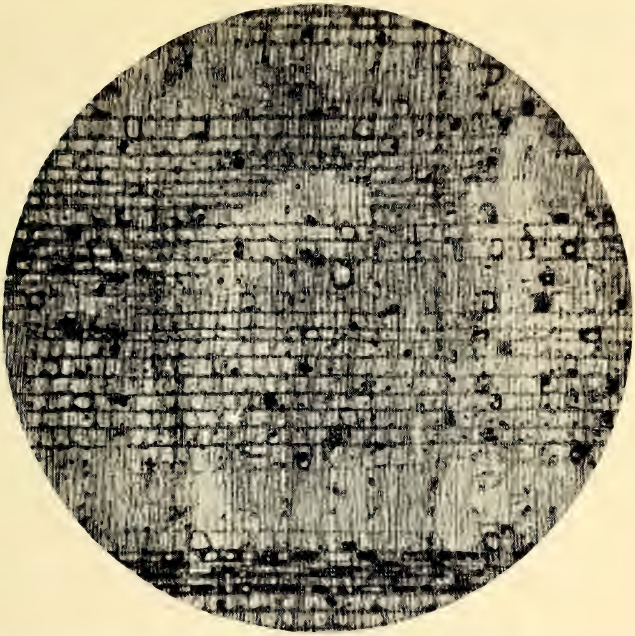
An extremely hard, close, compact timber, the fibres predominating over all other wood elements, wood parenchyma is limited, and only a few crystals were seen in these cells.

13. Eucalyptus pilularis, Sm. N.O. Myrtaceæ.

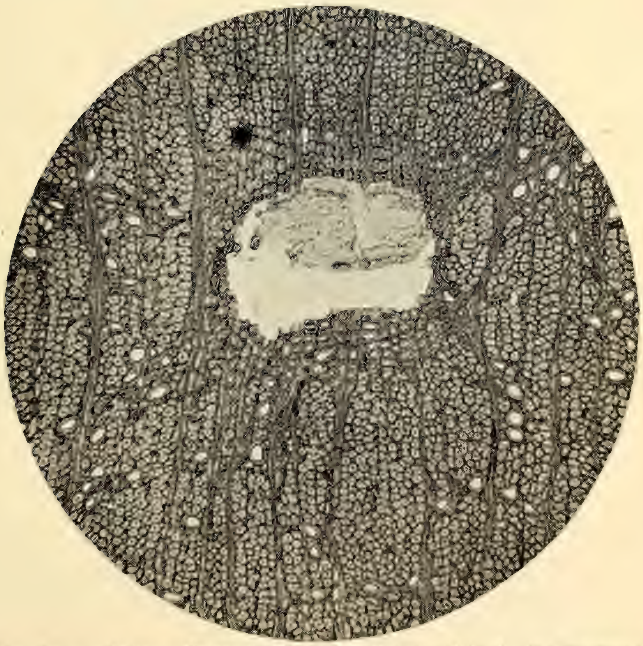
This timber has the reputation amongst workmen of having a grit. This is due however not to the presence of calcium oxalate but silica, from a test made by Mr. H. G. Smith, F.C.S.

14. Eucalyptus polyanthema, Schau. N.O. Myrtaceæ.

A very compact wood, the fibres arranged in radial rows, the lumen, like most red timbers, contains a deposit of that



Diospyros pentamera.—Radial section showing crystals in some of the ray cells. ×45.



Strychnos arborea.—Cross section showing crystals in the large wood parenchyma pockets. ×45.

Strychnos arborea.—Cross section, natural size. The white markings are not pores but calcium oxalate cavities.

Strychnos arborea.—Tangential section showing wood parenchyma (white streaks) filled with calcium oxalate.

colour. The crystals are not very numerous, but occur in both wood and ray parenchyma, especially the former, the latter also contains a red deposit.

15. EUCALYPTUS MELLIODORA, A. Cunn. N.O. Myrtaceæ.

The fibres may be classed as thick-walled, of a rather uniform dimension, with a lumen about one-third of the whole diameter. The perforations are numerous, opening by longitudinal slits which are often bordered. The pores are very numerous. The vessels have a rather delicate system of tyloses, and like the wood parenchyma (which is rather sparsely found), have no secretionary substance as obtains in so many Eucalypts. The rays are small, numerous, uniseriate, some of the cells have a yellowish secretion. The radial wall perforations of the cells are unusually large, round, and not of uniform diameter. The wood parenchyma is fairly well scattered amongst the wood elements, and in several instances crystals were found.

16. EUCALYPTUS SPP. IRONBARKS.

Most of the species forming the Ironbark group of Eucalypts contain calcium oxalate, more or less in the wood parenchyma, being most numerous in *E. Fergusoni* and least in *E. paniculata*.

17. DIOSPYROS PENTAMERA, F.v.M. N.O. Ebenaceæ.

A characteristic timber, and one not easily confounded with others, the fibres have fairly thick walls and small lumen, whilst the vessels also have unusually thick walls, both the wood and ray parenchyma are very interesting, as they contain in the cells three kinds of contents, crystals, a brown substance, and a very small spherical green body in malachite green.

18. STRYCHNOS ARBOREA, A.W. Hill. N.O. Loganiaceæ.

A close, hard grained timber, with irregularly packed fibres, numerous broad rays and small pores. Wood paren-

chyma is clustered around a very large one, in which is found a great deposit of apparently fine substance, described in the former part of this paper. See Plate XXX.

19. Bridelia exaltata, F.v.M. N.O. Euphorbiaceæ.

A fairly compact timber, the fibres of rather small diameter, and pores also small. Crystals are fairly numerous in the wood parenchyma.

20. Mallotus philippinensis, F.v.M. N.O. Euphorbiaceæ.

A timber with quite an unusual structure, the wood parenchyma being arranged in rows parallel to the rays and fibres, the latter having an exceedingly small diameter. The rays are of the multiseriate type, many of the larger cells containing large crystals, in some cases smaller ones were seen. It is the only instance in which a cell was found to contain more than one crystal.

21. Casuarina torulosa, Ait. N.O. Casuarineæ.

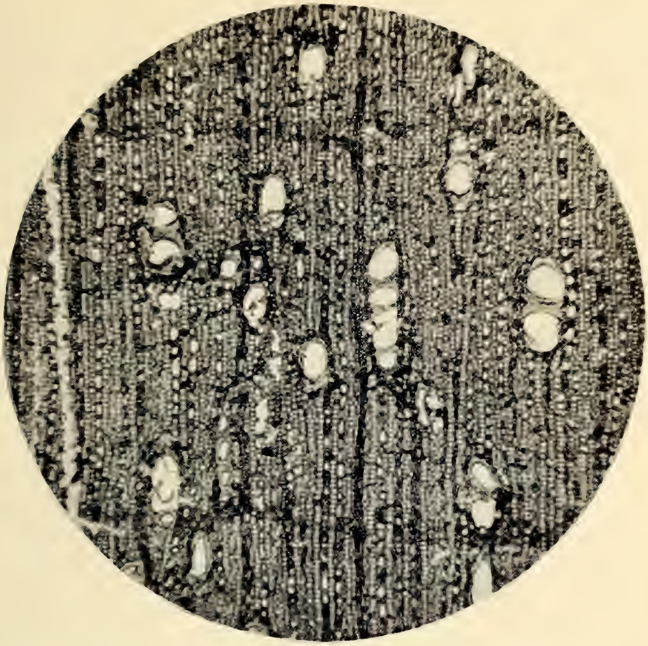
A close, compact wood, the fibres nearly always containing a brown deposit, as well as the vessels, which are thick walled. The large multiseriate rays are a distinguishing feature of this and all the Casuarinas, except *C. Cambagei.* The wood parenchyma is fairly numerous and extends in parallel narrow lines to the early and late growth, and appears to be of two kinds, one without and one with a deposit—amorphous and crystalline.

22. Casuarina glauca, Sieb. N.O. Casuarineæ.

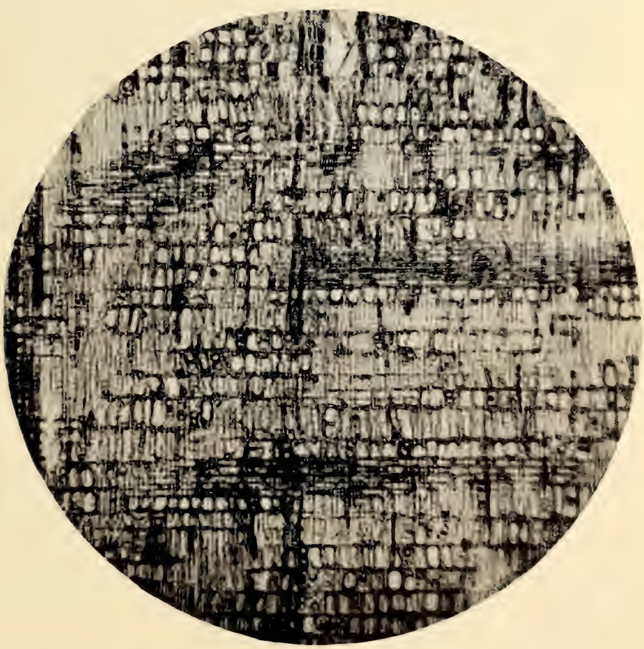
Crystals are fairly numerous in the wood parenchyma and of rather large size, and are seen in the transverse, radial and tangential sections, a very unusual circumstance.

Plates,—Micro-sections.

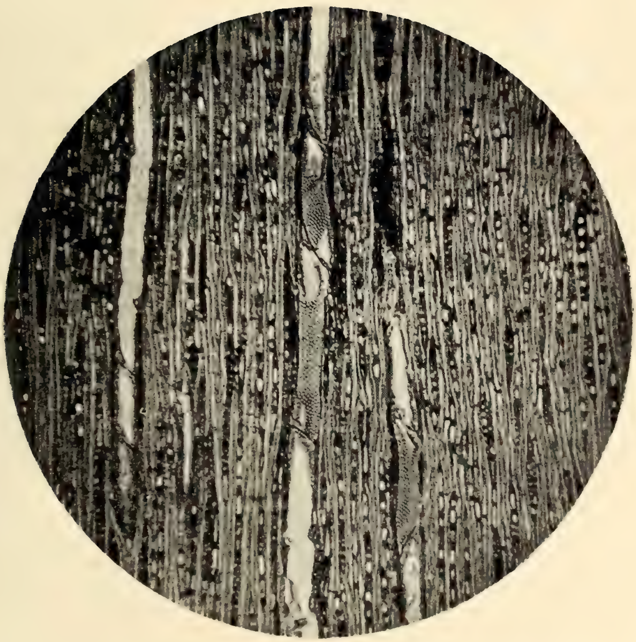
Plate XXV. *Pittosporum undulatum. Tarrietia argyrodendron.*
,, XXVI. *Flindersia australis.*
,, XXVII. *Acacia pendula.*
,, XXVIII. *Weinmannia lachnocarpa.*
,, XXIX. *Ratonia tenax. Rhodosphaera rhodanthema.*
,, XXX. *Diospyros pentamera. Strychnos arborea.*
,, XXXI. *Strychnos arborea.*
,, XXXII. *Mallotus philippinensis.*
,, XXXIII. *Mallotus philippinensis.*



Mallotus philippinensis.—Cross section showing crystals in the ray cells. ×45.



Mallotus philippinensis.—Radial section showing heterogeneous ray parenchyma with two or more crystals in an individual cell. ×45.



Mallotus philippinensis.—Showing end view of rays with crystals. ×45.

NOTES ON EUCALYPTUS (WITH DESCRIPTION OF A NEW SPECIES), No. V.

By J. H. MAIDEN, I.S.O., F.R.S., F.L.S.

[*Read before the Royal Society of N.S. Wales, December 5, 1917.*]

The arrangement of the species in the first portion of the paper is alphabetical.

1. E. ALBA Reinw. (including *E. platyphylla* F.v.M.) See Crit. Rev.[1] iii, 91, 95, 97.

"Lennard River, near Lukin's old station buildings; Isdell, Charnley, Calder and Ord Rivers; Dillen's Springs. Tree of 40 – 50 feet, trunk to 25 feet, diam. 1½ feet, bark greyish to reddish, thin, decorticating in strips, leaving the trunk and limbs smooth and cream-coloured; timber pale, rather soft and very brittle; leaves often five inches long by four inches broad; operculum double; filaments white—A "Cabbage Gum" of the Lennard River—In moist sandy loam overlying sandstone and quartzite." (W. V. Fitzgerald, MSS.). This supplements what has been hitherto recorded in regard to the North West Australian tree.

2. E. CÆSIA Benth. See Crit. Rev. iii, 31.

Through the kindness of Mr. W. C. Grasby, I have received specimens of this beautiful and little known Eucalypt from Mr. C. A. Fauntleroy, Uberin Hill, "in a gully of the granite hill," Dowerin, W.A. (Mr. A. E. Arney informed Mr. Grasby that the species also occurs about seventy miles east of Katanning, but no specimens were produced).

[1] My "Critical Revision of the Genus Eucalyptus."

Mr. Fauntleroy says "The bark has a long grained fibre and runs like Jarrah, and is not like Red Gum *(E. calophylla)* or Wandoo *(E. redunca)*, which have a short brittle grain. On the other hand the bark is composed of a number of thin layers or flakes, hardly as thick as a threepenny piece while green, and when dry are thinner still. The lower wood is shedding a layer now, which splits into narrow strips along the stem and breaks across at short intervals, some pieces curling vertically, others horizontally, but all curling. The new bark on the lower section is of a rich yellow-brown to orange-brown colour. The mid section, which will not shed a layer this year, is covered with a blue-grey bloom which rubs off on the hand and exposes bark of a reddish colour. The bark of the young wood and the top of the trees is red without the bloom powder. Grows Mallee style, about 12 feet high."

Specimens from Mr. Fauntleroy show it to have a smooth, tough bark, which strips in long lengths. The smooth bark has thin reddish-brown flakes, which fall off in succession.

Mr. Fauntleroy's specimens have enabled me to draw up the following additions to the description, and Miss Flockton to usefully supplement the drawing of the species in Plate 94 (Crit. Rev.).

The foliage sub-glaucous, the inflorescence and fruits very glaucous. Mature leaves,—veins very conspicuous.

Buds elongated pear-shaped, 2 – 3 cm. long, the tapering calyx-tube about 1·5 cm., with the bluntly conoid operculum about 1 cm. long. Four and five in an umbel.

Filaments pink, contrasting beautifully with the bright yellow anthers. (The precise colour is Vieux Rose. See Dauthenay's "Répertoire des Couleurs," vol. I, pl. 144, fig.4).

Pedicels stout, terete, up to 4 cm. long, fruits pendulous, peduncles terete, curved; fruits truncate-ovate in shape,

3 cm. long by 2·5 cm. broad, striate, tapering somewhat abruptly into the pedicel.

The affinity in anthers is with *E. pyriformis*, *leptopoda*, and *Oldfieldii* (see Crit. Rev. vol. 2); the resemblance in the fruits to those of *E. leucoxylon* F.v.M. var. *macrocarpa* J. E. Brown, (Crit. Rev. vol. ii, pl. 56, fig. 12) is considerable.

3. E. CAMPASPE S. le Moore. See Crit. Rev. ii, 203.

I am indebted to Mr. R. S. Richardson, late Acting Inspector-General of Forests of Western Australia for the following account by District Ranger Ferguson of a little-known species. It is sometimes known as "Salmon Gum," but it must not be confused with *E. salmonophloia* F.v.M.

"This tree is growing on a diorite hill near Coolgardie. It is a young tree (20 years more or less). It has no trunk, but the limbs appear to grow and spread from the ground more like a very large Mallee. The bark is much the same as Gimlet Gum (*E. salubris*) but the wood is not twisted. The wood is like the Salmon Gum *(E. salmonophloia)* in colour, and the leaves are more like the Salmon Gum in colour and growth. It is a late flowering tree and carries large quantities of seed vessels. This tree stands about 40 feet and its branches spread and droop like a willow. The thickest part of the tree is about eight inches in diameter, and the limbs spread from the ground."

I still have been unable to obtain the juvenile foliage and adventitious shoots ("suckers"), but the seedlings are petiolate and narrow-lanceolate.

4. E. CLELANDI Maiden. See Crit. Rev. ii, 189.

This Western Australian species has only previously been recorded from Goongarrie, and also from 70 miles north of Kurrawang, localities on the Eastern Goldfields close to each other. Dr. F. Stoward has now sent it (No. 86) from Bulla Bulling, about 20 miles west of Coolgardie, a locality

about 100 miles to the south-west from where it was previously known.

5. E. CONFLUENS (W.V.F.) Maiden, this Journal XLIX, 317.

The following is supplementary information from Mr. Fitzgerald's MSS.

"Summits of Mounts Behn, Broome and House, C 92, near the Synnott Range. Height about 30 feet, trunk to 15 feet, diameter to 1 foot. Bark persistent, white and smooth, timber brownish-red to red, very hard and extremely tough. Affinity (distant) to *E. rudis* Endl."

6. E. CONSIDENIANA Maiden. See Crit. Rev. i, 312.

Mr. W. H. Harvey, Yarram Yarram, Victoria, who calls this tree "Prickly Messmate," obligingly gives me the following information concerning its occurrence in that State.

"It is very scarce, is only found in small belts, chiefly in the parishes of Willung and Carrajung. The tree thrives best and creates a fine barrel or bole in volcanic soils or chocolate loams when it attains a height of about 50 feet in barrel and up to 3 feet in diameter. Called "Prickly Messmate" on account of the surface of the sapwood being covered as a rule with spikes or prickles. Has a yellowish-brown fibrous bark and the surface is smoother (less prickly to the touch) than either Stringybark or Messmate. Wood buff colour, fairly free from gum-veins and very durable. Mr. J. Wills, Chief Clerk of Works, Alberton Shire, speaks very highly of this timber and says that it gives as good results as any timber in the district."

7. E. ERYTHRONEMA Turcz. See Crit. Rev. iii, 24.

This has hitherto only been recorded with crimson (scarlet in my work, probably in error) filaments, and it is one of the showiest of the Western Australian species. Mr.

C. A. Fauntleroy of Dowerin in that State kindly sends, through Mr. W. C. Grasby of the "Western Mail," Perth, specimens with cream coloured filaments. He says "This plant has varicoloured flowers, from red and pink to white. It grows on dry country up to 12 feet in height. There are two or three stems per plant." This is an addition to the list of species with filaments of more than one colour.

Mr. W. V. Fitzgerald says—"A tree of 25 feet with a very crooked trunk of 10 feet; diameter 1 foot; bark greyish to white, smooth; timber reddish, rather brittle; filaments yellow or scarlet." (MSS.) Perhaps by "yellow" cream-coloured is meant; by "scarlet" probably crimson is meant.

8. E. Forrestiana Diels. Compare Crit. Rev. iii, 35 and Plate 95.

I have some specimens collected at Esperance in 1903 by Mr. Babington. The fruits are smaller and the wings are thinner and proportionately wider than have been described or figured. In Mr. Babington's fruits the width (excluding the wings) is about 1 cm., and the width (including the wings) about 1·5 cm., leaving the width of each wing at 2 – 3 mm.

9. E. gigantea Hook. f.

"I have repeatedly seen this species flowering profusely when about 6 feet high, sometimes when not more than 3 feet, and on several occasions when it had reached a height growth of between 2 and 3 feet. As this species rarely suckers, it appeared to me that the early and profuse seeding powers were a compensating characteristic of the species." (W.A.W.de Beuzeville, Forest Assessor, Forestry Commission, Sydney).

In another letter Mr. de Beuzeville says:—"Regarding your inquiry as to the state of the foliage of this species when in the early flowering stage of two or three feet, I

may say that you are quite right in your impression that it flowers in a juvenile leaf stage. I have often seen the flowers on these flowering saplings fully four inches broad and about five inches long." This therefore is to be added to the list of tree-species which also flower in a shrubby state, and also to the list of those that flower in a juvenile-leaved stage.

10. E. HOUSEANA (W.V.F.) Maiden. This Journal XLIX, 318.

The following is supplementary information from Mr. Fitzgerald's MSS. "Height 40 – 70 feet, trunk to 30 feet, diameter $1\frac{1}{2} - 2\frac{1}{2}$ feet, bark persistent, white to greyish-white, smooth; timber reddish, not very hard or tough... Fruit not seen...Affinity with *E. fœcunda* Schauer."

From additional material collected by Mr. Fitzgerald, the following additions to the description have been drawn up:—

Juvenile leaves.—Slightly glaucous, equally green on both sides, slightly stem-clasping around a nearly terete branchlet, oval to ovoid or broadly-lanceolate, tapering into a blunt or rounded apex, up to 18 cm. (say 7 in.) long by 8 cm. (say $3\frac{1}{8}$ in.) broad, secondary veins roughly parallel, at an angle of about 60° with the midrib and with abundance of fine anastomosing veins, the intramarginal vein well removed from the edge.

Fruits.—Conoid to hemispherical, small, (rather more than 5 mm. in diameter), nearly sessile, the short broad pedicel continued into the calyx-tube, forming two or more angles. Peduncle of 5 to 7 mm., also flattish and angular. The fruit with a narrow rim, the tips of the capsule slightly exsert and not adnate to the edge.

11. E. LUEHMANNIANA F.v.M. See Crit. Rev. i, 290.

The following information from Mr. Andrew Murphy extends the range of this species to the north. There is

about an acre of it (in a long strip), at the Kariong Trig. Station (807 feet), about four miles west of Woy Woy, and north of the Hawkesbury River about eight miles. The shrubs are about twelve feet high, with stems of two to three inches in diameter.

12. E. MACROCARPA Hook. See Crit. Rev. ii, 239.

The flowers of this rare species are amongst the very largest and most beautiful of the genus. The species is rarely seen in the bush (because of its inaccessibility from the larger centres of population), and much more rarely in cultivation, and inasmuch as there is variation in the colour of the filaments which has not been satisfactorily defined, the object of this note is to do something in this direction.

In Crit. Rev. ii, 241, I queried Mr. O. H. Sargents's note that the flowers were scarlet. This brought the following comments from that valued correspondent:—

"I was in Perth recently, and saw some cultivated specimens of *E. macrocarpa* just coming into bloom. The flowers were pale coloured. I took very careful note of the tint and would describe it as *pale carmine* red with a tendency to blue. I think, perhaps, crimson is the best general description of the flower's colour, but I cannot at all agree to "rich" crimson, bright crimson I should say at the utmost. Never have I seen a blossom of the species with anything like the depth of colour that is found in the flowers of *E. ficifolia*." (5/9/13).

"Driving home to York from Quellington a week ago I found one flower fully open on a shrub near that place. I brought it home and carefully compared its colour with the sample washes in Windsor and Newton's "Modern Water Color Pigments," (No. 43). Viewed from the side, the wash marked "carmine" is a perfect match for the colour of the stamens. From above, looking through the anthers, which are cream coloured, the mass of stamens perfectly

matches the wash marked "scarlet madder" (alizarin). I then placed the branch bearing the flower beside a scarlet geranium bush in full bloom, and going off ten yards or so carefully noted the colour impression given by the flowers of both plants. The Eucalyptus blossom was not sensibly different from those of the geranium. I asked my sisters their opinion of the colour; they were a little doubtful, but declared emphatically "it is not crimson." They agreed with my conclusions as to matching the washes. In brief, I have completely confirmed my original note that the flowers are properly described as scarlet." (29/3/13.)

On 17/9/13, I received from Mr. A.G. Hamilton a coloured drawing of the flowers he had made when he was in Western Australia. The colour is, according to Dauthenay, "Rép. de Couleurs," 'claret,' see plate 167, figs. 1 – 4. (It is only fair to say that it is often difficult to reproduce very bright colours in water colour.)

That of the flowers blooming in the Sydney Botanic Gardens, May, 1916, is "deep rose pink" of the same work, see plate 120, fig. 3. It is one of the species with ordinarily coloured filaments, which may also have "white" flowers. See Hooker's note, foot of page 239.

Now as to the arrangement of the filaments in the mass. Mr. Sargent writes me:—

"The figure 1a of Plate 77 strikes me as giving a scarcely correct impression of the flower. The blossom has always struck me as being remarkably square-cut so to speak. Stamens quite straight and all of precisely the same length," and then comes a footnote by himself:—"I mean by this that the mass of stamens is straight-sided and flat-topped. 'All of precisely the same length' is not correct."

Mr. Sargent's note is well borne out by Mr. Hamilton's drawing. It may not be clearly understood that my "Critical Revision" drawings are supplementary to those

of the "Eucalyptographia." If Mueller's plate of a species includes all the points, I have nothing to add to it, but Mr. W. D. Campbell's "rich crimson" (p. 239) specimen (1a, plate 77) seemed to possess a character which usefully supplemented Mueller's plate. I may mention that the "rounded" appearance of the filaments as seen in fig. 1a of Plate 77 (in contradistinction to the "square-cut" and "straight-sided" arrangement) is also seen in the Botanic Gardens, Sydney (cultivated) specimens, in two successive years (May, 1916, 13th August, 1917, the latter date being the date of the first throwing off of the operculum for 1917). Therefore in this species the filaments may be either "straight-cut" or "rounded" as depicted in the Crit. Rev. drawing to which I have referred.

It is also to be observed that on the filaments pushing off the thick, almost fleshy operculum, the inside of the operculum shows a partial "perforation" at the apex of the operculum, running nearly about half way towards the apex. This tunnel-like process represents a mould of the upper portion of the style and also the stigma.

Mr. W. Catton Grasby, Perth, usefully supplements my notes on the range of *E. macrocarpa:*—"It is almost invariably found on what we call sand-plains, that is the heath country. I cannot say how far it extends, but I have noticed it on the big sand plains between Wongan Hills and Bolgart which is north of Toodyay, also on sand plains about seventy miles east of Narrogin as well as east of York where it was evidently first located by Drummond. As you know, these sand plains generally occupy stretches of forest country which occupy depressions. If we take the word Guangan as an equivalent of what we call sand plain Drummond's meaning is perfectly clear."

13. E. MICROTHECA F.v.M. See Crit. Rev. i, 53.

Mr. W. V. Fitzgerald (MSS.) speaks of the Kimberley tree as "30 – 50 feet, trunk to 25 feet, diameter 1 – 2 feet,

branches often pendulous, bark persistent on stem and branches, dark grey, rather thick, rough and longitudinally fissured, often of a fibrous texture, timber red, hard and tough."

This could also be taken as a description of the tree as we usually find it in eastern Australia, but (*op. cit.*, p. 53), we have on the Murchison River, (limestone and vicinity of fresh water), and also in tropical coastal Western Australia, an undoubted white gum with a white-washed bark. The environments which have brought about these changes have not yet been explained. Perhaps we have a second species.

14. E. MINIATA A. Cunn. See Crit. Rev. iii, 38.

"A tree of 50 – 100 feet high, trunk to 40 feet, diameter to 3 feet; bark greyish to reddish, woolly-fibrous, rough and persistent on the lower half of the trunk sometimes covering the whole of it; limbs always white and smooth; timber red, very rough, hard,—flowers at a height of two feet—an inhabitant of poor sandy soil." (Fitzgerald MSS.)

The above notes refer to the tree as it occurs in North West Australia.

15. E. MOOREANA (W.V.F.) Maiden. This Journal, XLVII, 221.

The following is supplementary information from Mr. Fitzgerald's MSS.:—"Height 30 feet, trunk 10 feet, diameter 1½ feet, bark smooth, white and persistent, timber reddish, tough and moderately hard....In sandy soil overlooking sandstone and quartzite. Occasionally the leaves are quite connate and the calyces concrete...Affinity to *E. pulverulenta* Sims."

16. E. NAUDINIANA F.v.M. See Crit. Rev. ii, 79.

Mr. E. D. Merrill, Botanist, Bureau of Science, Manila, P.I., draws my attention to the fact that *Eugenia binacag*

Elmer, ("Leaflets Philippine Botany," vol. 7, p. 2351, 1914), and *Eucalyptus binacag* Elmer (*op. cit.*, vol. 8, p. 2776, 1915), Agusan Province, Mindanao, Philippines, are synonyms of the above species. See also Merrill in "Philipp. Journ. Science," C. Botany, x, 3 May, 1915, 207.

17. E. NITENS Maiden. See Crit. Rev. xix, p. 272, and Plate 81, figs. 9 and 10.

This imperfectly known and valuable forest species was hitherto only known from the Southern Monaro and towards the South Coast, N.S.W. A distinct addition to its range is shown in specimens collected by Forest Overseer Mattsson (communicated by Forester Gordon Burrows) from Nundle, 38 miles east of Tamworth. It occurs on the eastern fall of the Great Dividing Range, at an average elevation of 2,300 feet above sea-level (Forest Assessor Julius). Its range and abundance are being further inquired into. It does not attain the enormous dimensions of the Delegate trees, but it is still a tall tree, often 50 to 60 feet to the first limb. Bark described as "whitish, woolly not unlike that of our interior White Box in texture." It is locally known as "Scrub Box." The timber is much esteemed by saw-millers and reminds one of those of *E. goniocalyx* (Mountain Gum), *E. microcorys* (Tallow Wood), and *E. maculata* (Spotted Gum). The leaves of the northern tree also display those small tubercles irregularly distributed along the margins of the leaves, and are notable if only because they have so rarely been seen in the genus. Their occurrence on the southern trees has already been referred to.

18. E. OLDFIELDII F.v.M.

The specimen of Mallee from Burracoppin (Dr. J. B. Cleland), referred to at Crit. Rev. ii, 235 and figures 7a and 7b of Plate 75, is wrongly referred to *E. pyriformis* Turcz. var. *minor* Maiden. It is rather to be referred to

E. Oldfieldii with comparatively long, stout pedicels; the rims are concave.

19. E. OLIGANTHA Schauer. See Crit. Rev. ii, 160.

"Between Table Top Mountain and Artesian Range; near Charnley River, West Kimberley, North Western Australia. Tree of 40 feet; trunk to 15 feet; diameter to 1 foot; bark greyish, thin and smooth; timber reddish-brown, hard, and very tough; foliage scanty; filaments white; fruit *campanulo-urceolate*, under 4 lines long, rim thin, valves 4, included. In appearance bears a close resemblance to *Sterculia decipiens* W.V.F. On ferruginous sandstone which partly overlies andesite." (Fitzgerald MSS.) These notes supplement our knowledge of a little-known species.

20. E. SALIGNA Sm. var. PALLIDIVALVIS Baker and Smith. See Crit. Rev. iii, 59.

A supplementary locality is Blackall Range, Q. (C. T. White). It will probably prove to be widely diffused in Queensland.

21. E. STAIGERIANA F.v.M. See Crit. Rev. ii, 69.

"Scented Ironbark." We know so little about the restricted range of this especially valuable tree, that the following notes by Mr. F. G. de V. Gipps will be useful:— 1. Between Wolfram Camp and Thornborough. 2. On the Old Limestone Goldfield (between the Palmer and Mitchell Rivers); both localities are in the Cairns District, Northern Queensland.

22. E. TETRAPTERA Turcz. See Crit. Rev. xxii, 33.

This species has flowered for the first time in the Sydney Botanic Gardens. Flower-buds were first observed in February 1915, but the first operculum was not thrown off till 29th August, 1917. The following notes on the flowers may be useful :—

Calyx Lincoln red, Nos. 1 – 2 Plate 88, top of calyx or the inner flattish rim bronze yellow, Nos. 1 – 2 Plate 34. Filaments deep cerise, shading from Nos. 1 – 3 Plate 123. Colours taken from Rép. de Couleurs, Dauthenay.

The plants are stiff growing shrubs 4 – 5 feet high, with the foliage strikingly *Ficus* like. The leaves are leathery and the thickest I have seen in a Eucalypt. The midrib is continued 5 mm. beyond the leaf forming a rigid sharp mucro. Filaments tapering towards anthers. The wings of the calyx-tube terminate in short teeth at the commissure. The operculum is shallow and woody, and inside shows the mould of the top of the style and of the stigma. Exteriorly it shows cruciform raised ribs, and, in this respect at least it shows affinity with *E. erythrocorys*.

23. E. TORQUATA Luehmann. See Crit. Rev. i, 109, 120.

Bulla Bulling, W.A., December, 1916 (F. Stoward). Hitherto recorded only from the Coolgardie district and also from Widgiemooltha and Norseman (both south of Coolgardie, on the Esperance road; see my note in "Journ. W.A. Nat. Hist. Soc." iii, Jan. 1911.) The new locality is about 20 miles west of Coolgardie. It has flowered freely in the Sydney Botanic Gardens during the last four years, where a shrub of 3 feet 6 inches bears a profusion of palish pink flowers somewhat concealed by the leaves. It is a decided acquisition to horticulture.

The following is proposed as new:—

E. STOWARDI, n. sp.

Mallee vocatus ad 10′ altus. Foliis maturis coriaceis, nitentibus, lanceolatis, paullo falcatis, ca 11 cm. longis, 3 cm. latis maxima latitudine, longis petiolis 2 – 3 cm. Floribus teretibus pedunculis, pedicellis ad 5 cm. Alabastris magnis, clavatis, calyce tubo operculo minus dimidio æquante, ca. 1·5 cm. longo, 5 costis prominentibus in pedicellem angustatis, costis operculi longi paullo

angustati obtusi numerosioribus minore profundis. Fructibus magnis conoideis, 3 – 5 costis prominentibus, margine truncata planata, lata orificio parvo.

"A shrubby Mallee" with smooth bark.

Juvenile leaves not seen in their earliest stages, but broader, and with the intramarginal vein more remote from the edge than in the mature ones.

Mature leavės coriaceous, shining, of similar colour on both sides, covered with fine black dots, with long petioles (say 2–3 cm.) lanceolate, asymmetrical, slightly falcate, tapering gradually to an apex consisting of a soft point, about 11 cm. (say 4½ inches long) and 3 cm. broad in its widest part.

Flowers with a terete peduncle of 2 – 2·5 cm., about seven in the head, with flattened pedicels up to ·5 cm. The buds large, clavate, the calyx-tube longer than a third of the operculum, about 1·5 cm. long, with five prominent ribs tapering into the pedicel, the long slightly tapering blunt operculum with more numerous, shallower ribs than those of the calyx-tube.

Filaments cream-coloured, sometimes with a purplish flush at the base, tapering trigonous or tetragonous, ribbed, with numerous glands, anthers large with parallel cells and large gland at back.

Fruits conoid, with three to five more prominent ribs and a number of intermediate shallower ones, with a truncate, flattish, slightly rounded, broad rim, with a small orifice; tips of the valves sunk or scarcely flush with the orifice.

Kwelkan, on the Northam-Merriden line, a few miles north of Kellerberrin, Western Australia (Dr. Frederick Stoward, Government Botanist and Plant Pathologist, No. 150, April, May, 1917). The type.

The material is scanty, and it would appear that the following specimen also belongs to this species. As this material is also sparse it is desirable to describe it.

A shrub or "small tree, the highest I have seen does not exceed 10 feet." Bark of a smooth, dull grey. Branchlets round, more

or less glaucous, as also the petioles, young leaves and fruits, the whole plant perhaps largely glaucous at certain seasons.

Juvenile leaves. Not seen.

Mature leaves. Very thick, coriaceous, dull to shiny, of an olive green, and the same colour on both sides, lanceolate to ovate, petiolate, the base ending rather abruptly in a petiole of 2 cm., the lanceolate leaves mostly tapering into a fine point, about 10 cm. (4 inches) long, or shorter, and about 2·5 cm. ($1\frac{1}{2}$ inch) broad, both surfaces entirely covered with innumerable fine black dots, the midrib and secondary veins moderately prominent, the secondary veins spreading and roughly parallel, making an angle of about 45° with the midrib, the intramarginal vein distinctly removed from the edge.

Buds. Cylindroid, the blunt cylindrical operculum about twice as long as the slightly ribbed calyx-tube, about 5 to 8 in the umbel, on a decurved peduncle of 2·5 cm., each calyx-tube gradually tapering into a pedicel of under 1 cm.

Flowers. "The bloom is evidently a large pale yellow." (Vachell). Anthers large, with parallel cells and large gland at back.

Fruits. Moderately large, conoid, flat-topped, rather gradually tapering into a flattish pedicel, with two especially prominent longitudinal ribs or wings running from the rim and causing an expansion of the pedicel, together with a number of less prominent ribs of which two are only secondary to the main ones, rim moderately broad and flat, with four deltoid or acicular tips of the valves distinctly protruding beyond the orifice and encased with the whitish remains of the capsule-lining.

"Baronrath," viâ Kellerberrin, W.A. Flowers and ripe fruit, September, 1903, nearly ripe fruit, December, 1903, (F. Harvey Vachell).

"Grows on the sand-plains about here. I have only met with a small group of them." Although I have made a number of attempts to obtain additional material I have

been unsuccessful, and I trust that the present descriptions will lead to its recovery.

Affinities.

1. With *E. erythronema* Turcz. See Plate 93, Part xxii, of my "Critical Revision of the Genus Eucalyptus." The leaves of *E. erythronema* are narrower, the pedicels longer, the calyx-tubes not ribbed, the filaments pale and not glandular, the opercula conical, the fruits smaller, more flat-topped and less constricted at the orifice. The anthers are not dissimilar, and it would appear that *E. Stowardi* and *E. erythronema* are closest allied.

2. With *E. Forrestiana* Diels. See Plate 95, Part xxii, of my "Critical Revision of the Genus Eucalyptus." In *E. Forrestiana* the peduncle is longer, the pedicels more articulate, the anthers more rounded, the filaments less grooved, though glandular. The opercula shorter, more conoid, and less in diameter than the calyx-tube. The fruits larger and more quadrangular, the ridges more pronounced.

3. With *E. occidentalis* Endl. It appears to be closest allied to this species, but the peduncle is flat in *E. occidentalis* and terete in *E. Stowardi*. In some forms of *E. occidentalis* we have also glandular filaments. The buds of *E. occidentalis* are more terete, *i.e.*, less ribbed; the fruits more urceolate and the valves more exsert, with a much thinner rim.

4. With *E. incrassata* Labill. var. *angulosa*. Compare Plate 14, Part iv, of the "Critical Revision of the Genus Eucalyptus." The foliage of var. *angulosa* is coarser, the peduncle strap-shaped, the operculum shorter and it and the fruit more corrugate.

5. With *E. Pimpiniana* Maiden. See Plate 72, Part xvi, of the "Critical Revision of the Genus Eucalyptus." Attention may be drawn to the imperfectly known *E.*

Pimpiniana to which it is also related, but less closely so. The fruits of *E. Pimpiniana* are more ovoid and less ribbed.

E. AMYGDALINA Labill.

E. RADIATA Sieber (Syn. E. AUSTRALIANA Baker and Smith).

E. NUMEROSA Maiden.

Messrs. Baker and Smith (This Journal, xlix, 514, 1915), supplementing an earlier paper in "Proc. Roy. Soc. Tas." 1912, state that *E. amygdalina* Labill. is confined to Tasmania, and that the plant which has so long gone under that name on the mainland is a new species, to which they give the name *E. australiana.* It is proverbially difficult to prove a negative, but in the strict sense in which Messrs. Baker and Smith interpret *E. amygdalina*, I agree with them that it has not been found on the mainland so far. In view, however, of the fact that a number of species of this and other genera occur both in Tasmania and the mainland, a widely diffused Tasmanian species such as *E. amygdalina* should be looked for on the Victorian coast, and in more elevated localities in both Victoria and New South Wales.

E. RADIATA Sieber. "Narrow-leaved Peppermint."

I do not, however, agree that the mainland species is undescribed; it has, indeed, several synonyms.

The authors do not mention what their type of *E. australiana* is, "the localities being too numerous to publish here," (p. 516), but we know precisely what is meant, for at p. 514 they give a reference to their "Research on the Eucalypts," p. 168, with a plate (as *E. amygdalina)*, and through the 1915 paper we have reference to its occurrence at "Nerrigundah, Yourie and neighbouring districts of New South Wales," Tanto, Moss Vale and Reedy Creek, all in the same State, while I have received a specimen from the authors from Batlow. In addition, before and

since the reading of Messrs. Baker and Smith's paper, I have received copious additional material from the localities they mention from correspondents and the Botanic Gardens Collector. This widely diffused species is *E. radiata* Sieb., in other words, the mainland form attributed to *E. amygdalina* Labill.

It was originally figured, as a line drawing, at Plate 7, "Mém. sur la Famille des Myrtacées" (A. P. de Candolle, 1842).

In Proc. Linn. Soc. N.S.W., xxix, 751 (1904), and Crit. Rev. vi, 153 (1905), I said "*E. radiata* Sieb., appears to be nothing more or less than a form of *E. amygdalina*, very common in New South Wales, and I see nothing distinctive enough to warrant its being called a variety." I pointed out some differences from the Tasmanian *amygdalina*, but did not take the step, which I think Messrs. Baker and Smith have rightly done, of separating the Tasmanian and Australian trees. Plate 62, Part xvi of my "Forest Flora of New South Wales," labelled *E. amygdalina*, and drawn from a Blue Mountains specimen, is *E. radiata*, and, excluding the Tasmanian references, this Part gives a convenient popular account of the species now under reference.

E. radiata has been known as a copious oil yielder for many years. A Mr. Simmonds of Marulan sent it to me, August, 1892, and informed me that he was distilling it, while on the higher parts of the Blue Mountains and of the southern tableland, everyone knows how the vicinity of such trees markedly reeks with oil during rain, or on the approach of a mountain mist. I dwell on the redolence of oil in this species under the caption "A beautiful and health-promoting tree" in my "Forest Flora of N.S.W." Part xvi, p. 132. We did not, however, know the composition of the oil until the publication of Messrs. Baker and Smith's paper, where they call it *E. australiana*.

The authors (p. 514) recognise a broad-leaved form of *E. australiana*, restricted to the Ovens district of Victoria. As a matter of fact *E. radiata* (*australiana*) varies in width of leaf, thickness and glaucousness. I have broad-leaved plants from both Victoria and New South Wales. Within the limits the texture and venation vary according to environment, age of plant, and part of tree from which the leaves have been obtained.

The fruits *(E. australiana)* are described as pilular to turbinate, with a red rim. The fruits of *E. radiata (australiana)* vary in size and shape, (being nearly spherical to pear-shaped), thickness of rim, shininess, length of peduncle and pedicel. Variation in shape depends to some extent on degree of ripeness and environment.

It is desirable to state the range of the species, and the following statement, based on specimens in the National Herbarium, Sydney, will be sufficiently comprehensive. It will probably never be known precisely where Sieber obtained his type, since no dated specimens or diary by him are known. It was doubtless obtained either in "Argyle County" or the Blue Mountains, both districts he is known to have visited, and specimens of his type have been compared, and precisely match specimens from both those localities.

Victoria.—Mr. H. Hopkins in "Advance Australia," October, 1909, says that it occurs from sea-level to 3,000 feet in Victoria. It is found on the Upper Yarra, Daylesford, Mount Macedon, North and South Gippsland, and away to the high tablelands, joining on to the high localities in New South Wales.

New South Wales.—It is extensively distributed in New South Wales, being a denizen of rather cold localities. In the south it is found on the tableland generally ascending the mountains to Yarrangobilly, Tumbarumba, etc. (These

are but representative localities in this region). It occurs at Wyndham, Burrinjuck, Mount Stromlo (Federal Territory), Nerrigundah, Yourie and between Cobargo and Tilba Tilba, the Araluen-Braidwood district, Goulburn to Hill Top.

In the west it extends from Woodford to the highest part of the Blue Mountains, including Mounts Wilson and Tomah, Mount Blaxland to Rydal and again at Mullion Creek near Orange, which appears to be the furthest in this direction. It also connects by many localities with the Southern Tableland, forming continuous areas or chains of localities.

Going north we have it in the Nundle district and in the higher eastern slopes leading to and upon New England generally, extending as far north as Wilson's Downfall, which is no great distance from the Queensland border. Chains of localities connecting west and north require to be worked out.

Speaking more concisely, it occurs in Eastern Australia, including both Victoria and New South Wales, being found at no very great distance from the coast until a hundred miles south of Sydney is reached, and then, going west and north, it gradually ascends the tableland, chiefly of New England, increasing the distance from the coast. It is hard to believe that it will not be found about Stanthorpe or in other Queensland localities on the Macpherson Range.

E. NUMEROSA Maiden, "River White Gum."

Proc. Linn. Soc. N.S.W., xxix, 752 (1904). Following are synonyms:—

E. AMYGDALINA Lab. var. *radiata* Benth. (B.Fl., iii, 203) in part, but not *E. radiata* Sieb.

E. NUMEROSA Maiden in Part xvii, p. 146 of my "Forest Flora of N.S.W." with Plate 66 (1905).

E. AMYGDALINA Labill. var. *numerosa* Maiden, "Crit. Rev. vi, 155, with fig. 1, plate 30 (1905).

I did wrong in temporarily suppressing *E. numerosa;* it is a distinct species. This step originally arose through accepting the view of Bentham (B. Fl. iii, 203) that *E. radiata* included the plant which we know as *E. numerosa.*

Use of botanical names for trade purposes.—Messrs. Baker and Smith (p. 515) put in a plea for the use of botanical names for commercial products, a view I have actively supported for many years, but if this principle be not very judiciously applied, instead of good resulting, the divorce between the Eucalyptus nomenclature of botanists and that of commercial men will be widened. In the case of a species name such as *Eucalyptus globulus*, and a very large number, indeed the vast majority of species, there are no differences of opinion as to validity; in other words, the scientific name can be used for timber or oil or any other branch of commercial nomenclature with perfect safety. But the use of such a name as *Eucalyptus australiana*, which has not one, but many synonyms, is on a different footing, and its use for trade purposes leads to the very confusion we all desire to avoid. A firm receives this name in perfectly good faith, indeed it may not have the knowledge on which to form an independent opinion; oil is supplied under that name to its numerous customers. The name becomes involved in trade-transactions, and, having once adopted it, a firm naturally becomes unwilling to withdraw it. In other words, a non-botanist takes sides, and he is actuated by one of the strongest of human motives, pecuniary interest, and there is no doubt that, money being at stake, the commercial name will be closely adhered to, to an extent measured by the demand for the oil, irrespective of any evidence the dissentient botanist may adduce. This unfortunate state of affairs, which may obstruct endeavours to arrive at a settled nomenclature, is always liable to take place in the case of acceptance of any botanical

name for trade purposes before it has been thoroughly tested. In other words, we shall probably find it necessary, in future, to employ two lists, one the stereotyped list that the stability of trade requires, and a second list of equivalents according to the laws of botanical nomenclature. It is not the fault of botanists that the nomenclature of Eucalyptus cannot be stereotyped in 1917. A really remarkable amount of work has been done in this direction, particularly during the last twenty-five years, and while all species will not be discovered and examined, even in a century to come, I consider that it would be a feat of which botanists might be proud, if they find themselves able to secure a fairly stable nomenclature of species in this genus in the course of a further twenty-five years.

CINEOL AS A SOLVENT IN CRYOSCOPY.

By CHARLES E. FAWSITT and CHRISTIAN H. FISCHER.

[*Read before the Royal Society of N. S. Wales, December 5, 1917.*]

CINEOL is an important constituent of many Eucalyptus oils and it is now easily procurable in a fairly pure condition. Its composition is given by the formula $C_{10}H_{18}O$. It was thought that its value as a possible solvent for cryoscopic determinations was worth investigation.

The cineol was obtained from Hudson's Eumenthol Co., Sydney, where, we understand, it is obtained from eucalyptus oil, which is rich in cineol. The cineol is obtained from the oil by freezing out this constituent. We distilled the cineol and found that most of it came over at 175° – 176° C. The freezing point of the distilled cineol was 0·1° C. The figure usually given for the freezing point of cineol is −1°C., but this latter figure is too low.

Pure cineol is exceedingly hygroscopic, and owing to the relatively small molecular weight of water, small amounts of absorbed water depress the freezing point very much. An addition of 0·2% of water was found to depress the freezing point of cineol 0·54° C.

In order to test whether the distilled cineol had any considerable amount of moisture in it, a current of air, dried by sulphuric acid, was passed through the solution for three quarters of an hour, when the freezing point rose to 0·2° C. Some distilled cineol was next allowed to stand over sodium for twenty-four hours and redistilled; its freezing point was found to be 0·9° C.

Cineol as a Solvent in Cryoscopy.

For the first determinations given below, distilled cineol of F.P. 0·1° C. was used. This contained a small quantity

of water but was easier to work with than the purer cineol of F.P. 0·9° C. used in the later determinations.

The use in cryoscopy of a solvent containing slight impurities is justified if the depressions of the freezing point caused by additions of various solutes are the same as they would have given with the purer solvent. Whether this is so, is a matter for experiment in any particular case.

We have found that when benzene is used as a solute, exactly the same results were obtained with the ordinary and the dried cineol, and we believe that the influence of this small quantity of moisture is negligible for its use in the determinations given below.

The usual apparatus with a Beckmann thermometer was used for these determinations, except that the stirrer was fitted with a mercury seal, in order to exclude air with its attendant moisture. Without this, or other suitable contrivance for preventing moisture from entering, it is impossible to obtain results that can be depended on.

After the freezing point had been registered in any particular determination, the tube containing the solvent and solute was warmed up to nearly the room temperature (16° – 23° C.) before refreezing to obtain another reading. This method gave better results than heating the semifrozen liquid just sufficiently high to melt all solid.

In the following tables "*K*," the cryoscopic constant, is the depression in the freezing point caused by dissolving one gramme-molecule of the solute in 1000 grammes of cineol.

"*K*" is calculated from the formula

$$K = \frac{m \times \triangle \times W}{w \times 1000}$$

Where m = molecular weight of the solute.

$\triangle$ = depression of the freezing point in degrees centigrade.

w = weight of solute used (in grammes).
W = weight of solvent used (in grammes).

The solutes used were Kahlbaum's in the case of benzophenone, nitrobenzene, bromobenzene, toluene, benzene, butyl alcohol, and were used without further purification. The chloroform used was Mercks'. The ethyl alcohol used was Mercks', and was distilled after being in contact with quicklime for twenty-four hours. The ether was Kahlbaum's and was distilled after being in contact with sodium for twenty-four hours.

TABLE I.

Solute:—Benzophenone $(C_6H_5)_2CO$; m = 182.
Weight of solvent (cineol) = 14·258 grammes.

w.	Percentage of solute to solvent.	$\triangle$	K. (calculated)
0·1186	0·832	0·308	6·7
0·2026	1·421	0·532	6·8
0·2752	1·930	0·696	6·6
0·3870	2·714	1·044	7·0
			Average 6·75

TABLE II.

Solute:—Nitrobenzene, $C_6H_5NO_2$; m = 123.
Weight of cineol = 16·06.

w.	Percentage of solute.	$\triangle$	K. (calculated)
0·2054	1·279	0·655	6·4
0·2946	1·834	0·953	6·4
0·5068	3·156	1·651	6·4
0·6572	4·092	2·176	6·6
			Average 6·45

TABLE III.

Solute:—Bromobenzene, C_6H_5Br; m = 157. W = 16·02.

w.	Percentage of solute.	$\triangle$	K.
0·197	1·23	0·54	6·9
0·3444	2·15	0·949	6·9
0·4872	3·04	1·317	6·8
0·6386	3·98	1·703	6·7
			Average 6·8

TABLE IV.

Solute:—Toluene, $C_6H_5CH_3$; $m = 92$. $W = 24{\cdot}69$.

w.	Percentage of solute.	Δ	K.
0·203	0·822	0·599	6·7
0·403	1·63	1·199	6·8
0·613	2·48	1·814	6·7
0·849	3·44	2·508	6·7
			Average 6·7.

TABLE V.

Solute :—Benzene, C_6H_6; $m = 78$. $W = 20{\cdot}31$.

w.	Percentage of solute.	Δ	K.
0·1902	0·937	0·788	6·6
0·3452	1·70	1·428	6·6
0·5220	2·57	2·155	6·5
0·8422	4·15	3·428	6·4
			Average 6·5

TABLE VI.

Solute :—Chloroform, $CHCl_3$; $m = 119{\cdot}4$. $W = 19{\cdot}19$.

w.	Percentage of solute.	Δ	K.
0·22	1·146	0·639	6·7
0·4136	2·156	1·20	6·7
			Average 6·7

TABLE VII.

Solute :—Ethyl ether, $(C_2H_5)_2O$; $m = 74$. $W = 18{\cdot}27$.

w.	Percentage of solute.	Δ	K.
0·1292	0·707	0·624	6·5
0·2698	1·477	1·275	6·4
0·4016	2·2	1·875	6·3
0·6210	3·4	2·875	6·3
0.94	5·15	4·255	6·1
			Average 6·3.

From these results the value of the constant (K) may be taken as 6·7. This holds good for dilute solutions and for unassociated solutes.

Cineol itself does not appear to show any abnormal behavious in these experiments, and molecular weight determinations of cineol (as solute) dissolved in benzene (solvent), gave a normal result for the molecular weight of cineol. The values of the constant "K" for cineol in some of the tables given above decrease with increasing concentration of solute, but this is a peculiarity often noticed in such freezing point experiments, and it may be taken that the more correct value for the constant is that obtained in the dilute solutions.

The molecular weight of substances containing the group hydroxyl, would be expected to be abnormal (too large) in solution in cineol, as this abnormal character of such solutes is noticed with other solvents. *Vice versa*, the calculated values of "K" using the normal molecular weights for alcohols should come out rather low.

TABLE VIII.

Solute:—Ethyl alcohol, C_2H_6O; $m = 46$. $W = 16{\cdot}90$.

w.	Percentages of solute.	Δ	K.
0·1478	0·875	1·113	5·8
0·3834	2·27	2·645	5·4
0·6934	4·105	4·356	4·9

TABLE IX.

Solute:—Butyl alcohol, $C_4H_{10}O$; $m = 74$. $W = 18{\cdot}02$.

w.	Percentages of solute.	Δ	K
0·132	0·732	0·60	6·1
0·398	2·21	1·744	5·8
0·691	3·84	2·877	5·5

From these results we conclude that these alcohols are associated in solution in cineol. Comparing cineol with other solvents, we find it is somewhat more difficult to carry out determinations with cineol as solvent, than with benzene or water, but we believe that cineol will be found a useful solvent in some cases.

The latent heat of fusion for cineol is given by the formula

$$L = \frac{RT^2}{K \times 1000}$$

where L = latent heat of fusion of 1 gramme of cineol, $R = 1·985$, and T = absolute temperature of melting point of cineol = 274° C. The latent heat of cineol (1 gramme) is therefore 22·2.

Summary.

1. Cineol is a hygroscopic substance and the usual freezing point given is too low. Cineol purified from dissolved water was found to freeze at 0·9° C.

2. The freezing point constant for normal solutes in cineol as solvent is 6·7.

NOTES ON AUSTRALIAN FUNGI, No. IV.

POLYPORUS, FOMES AND HEXAGONA.

By J. BURTON CLELAND, M.D., and EDWIN CHEEL, Botanical Assistant, Botanic Gardens, Sydney.

[*Read before the Royal Society of N.S. Wales, December 5, 1917.*]

THROUGH the kind assistance of C. G. Lloyd of Cincinnati, Ohio, most of the Australian polypores in our possession have been accurately identified. In the present paper we record our various collections. In doing so, we make use of the excellent keys employed by Lloyd in the following works:—'Synopsis of the Genus Hexagona' (Ohio, 1910), 'Synopsis of the Stipitate Polyporoids' (Ohio, 1912), 'Synopsis of the Section Apus of the Genus Polyporus' (Ohio, 1915) and 'Synopsis of the Genus Fomes' (Ohio, 1915). In addition to recording the plants we have handled, we have included as well all the Australian species embraced in these works. Australian mycologists should thus have available a workable scheme for the identification of most of our firmer polypores. Those who have attempted to work out the species from Cooke's 'Handbook of Australian Fungi,' will appreciate the value of Lloyd's work.

We deal first with the Stipitate Polypores, then with *Fomes*, *Polyporus (Apus)* and *Hexagona*.

I. STIPITATE SPECIES OF THE GENERA FOMES, POLYPORUS AND POLYSTICTUS.

Sub-woody.—With woody fibrils but not perennial and not having the pores in strata (except as to the first).

Pores in areas of growth indistinctly stratified. *Fomes.*

Pores not stratified.

Spores coloured, mostly elliptical, with a strong apiculus. Context coloured. Surface of most species laccate.—*Ganodermus.*

Spores coloured, mostly globose, with none or a small apiculus. Context coloured. Surface of most species dull.—*Amaurodermus.*

Spores white. Context (except Section 11) pale or white.—*Lignosus.*

Fleshy or coriaceous.

Stipe lateral. Spores white.—*Petaloides.*

Stipe branching and bearing several pileoli.–*Merismus.*

Stipe central or excentric (rarely lateral). Flesh spongy, light. Spores white or coloured.—*Spongiosus.*

Spores coloured. Fleshy or coriaceous.—*Pelloporus.*

Spores white. Fleshy, soft, usually terrestrial, with thick pilei.—*Ovinus.*

Spores white. Fleshy-pliant, coriaceous, usually with thin pilei and epixylous.—*Lentus.*

Lentus with black stems.—*Melanopus.*

First Division—FOMES (Stipitate).

Section 1. Lloyd records only one species, which is not Australian.

Second Division—GANODERMUS.

Section 2. Spores smooth or but slightly rough.

1. Polyporus (Ganodermus) lucidus, var. japonicus Fries.
 Syn. *Fomes lucidus* Fr., (Cooke, No. 673).

Cooke records *Fomes lucidus* for Queensland and Tasmania. As all our Australian specimens appear to be the variety *japonicus*, we record this form only for Australia.

In September, 1911, specimens of a fungus were exhibited at a meeting of the Linnean Society of New South Wales from Catherine Hill coal-mine near Newcastle, N.S.W., under the name *Fomes lucidus.* One consists of a long

black laccate stem 11 ins. in height and about $\frac{3}{8}$ in. long, whose summit has become twisted and bent. The larger specimen has about fifty concentric rings on the stem, giving it a snake-like appearance. As the context resembles in colour that of the specimens we are considering, we think that this is probably an anomalous form which has been unable to fruit. Probably each ring represents a separate growth effort, dependent on access of moisture and so not necessarily annual.

In May, 1915, and again in June, 1916, specimens of a polypore were collected near the base of a decaying Casuarina stump near Lisarow. Lloyd has kindly identified these for us as *Polyporus japonicus*. He says:—"Certainly a form of *P. lucidus* with *dark context colour and dark surface.* The Japanese plant which passes as *Polyporus japonicus* in Japanese works differs from *P. lucidus* in this way. Your specimen also departs in having a lateral stipe in the same plane and in being tubercular deformed." Our specimens are fan-shaped, usually about 3 ins. in diameter and with the upper surface dark brownish-black and rugose and very dull laccate. The stipe is very short but shews a dorso-lateral attachment. The context is a dark cinnamon and the pore orifices a dull brown. The spores were brown, smooth and $11 \times 5{\cdot}5$ to $6{\cdot}5\mu$ in size.

The National Collection has the following specimens:— A very large fan-shaped one, 7 ins. long by 8 ins. wide, with a stem $2\frac{1}{2}$ ins. long, and another smaller plant, Atherton Scrub, North Queensland (R. Mitchell, August, 1911); a fan-shaped specimen from Eumundi, Queensland (J. Staer, 1911); a finger-like form, Ingham, Herbert River, North Queensland (Sid. W. Jackson, 1908).

2. Polyporus (Ganodermus) amboinensis Fries.

Syn. *Fomes amboinensis* Fr. (Cooke, No. 672). Queensland. Var. *gibbosus* (Cooke, No. 672), Queensland.

3. Polyporus (Ganodermus) fornicatus Fries.

Lloyd states that plants similar to this species but with rougher spores occur in Australia.

Section 3. Spores distinctly rough.

4. Polyporus (Ganodermus) ochrolaccatus Mont.

"Pileus small but deep, attached by a short rudimentary, dorsal stem. Crust *pale*, *ochraceous*, faintly laccate, rugulose, zoned. Pores medium with white mouths, long, not stratified but reaching the crust, very regular, arranged in lines. Spores large, $16 \times 32 (?) \mu$, with small apiculus, distinctly rough."—Lloyd.

Lloyd has identified specimens for us collected at Port Moresby, New Guinea, by A. E. Pratt.

Section 4. Anomalous section with a false stem. No Australian species recorded.

Third Division—AMAURODERMUS.

Section 5. Polyporus. Spores smooth or but slightly rough. Stem slender, usually mesopodal.

5. Polyporus (Amaurodermus) rudis Berk.
Syn. *Fomes rudis* Berk. (Cooke, No. 669).

This is a quaint species not uncommon in the Sydney district but of no importance in forestry. It grows on the ground and has an irregular cinnamon-brown stem, sometimes three inches long or more, and a dark brown irregularly wrinkled cap up to three inches across.

Cooke records also *A. rugosus* (No. 671) for Victoria, Queensland and New South Wales. Lloyd, in speaking of *A. rudis* of Australia says:—"It is close (too close perhaps) to *rugosus* of the East, but seems to be more rugulose, has larger pores and spores ($9-12$ as against $6-8$ or $8-10\mu$), and when mature retains its colour." Such being Lloyd's opinion we refrain from including *A. rugosus* amongst

Australian species until the identification of Australian specimens is more certain. As regards *Fomes pullatus* (Cooke No. 670), recorded from Victoria and Queensland, Lloyd says:—"This is a manuscript name that Berkely gave to an old specimen from Hong Kong, but afterwards concluded that it was *rudis* of Australia and did not publish it. Cooke afterwards dug it up and published it. I do not think the old specimen is *rudis*, but it was too poor to publish." In view of this, the Australian records are best referred to *A. rudis*.

We have specimens of *A. rudis* from several sources, which may be briefly described as follows:—

Lane Cove, Sydney (A. A. Hamilton), August 1901, at base of a dead tree. Pileus convex, up to 3 ins. in diameter, dark brown, in old specimens blackish, radiately plicato-rugose and slightly so concentrically, tendency to umbilication with central umbo. Stems central to excentric, comparatively slender, irregular, up to 3 ins. long, finely velutinate, dirty cinnamon becoming black. Pores dark brown, becoming blackish. Context pale cinnamon. Spores 11 to $12 \times 8{\cdot}5$ to $10{\cdot}3\mu$, thick walled, brown, nearly smooth.

Penshurst, Sydney (E. Cheel), May 1910, at base of an old stump. Pileus irregular, convex, less rugose than the preceding, dark brown, matt. Stems irregular, up to $4\frac{1}{2}$ ins. Pores pallid. Context same tint as the preceding. Spores $11 \times 8{\cdot}5\mu$, smooth, brown.

Linnean Society's Garden, Sydney (J. J. Fletcher), Nov. 1907. Pileus dark brown, 6 ins. in diameter, knobbily rugulose, slightly umbilicate. Hymenium flat, pores dark brown (old). Stem $4\frac{1}{2}$ ins., irregular, moderately stout. Spores $10{\cdot}5$ to $11 \times 9\mu$.

Terrigal, N.S.W. (J. B. Cleland), June 1914. Description when fresh:—Pileus dark brown, rugose, plane (convex

when dry). Orifices of pores pallid, turning reddish when bruised. Tubes dark brown, at once turning black as do the orifices when deeply pressed. Substance pallid, turning a deep brown. Stem dark brown, smooth, violet-tinted pith. On the ground.

Near Lisarow in May 1915 a group of individuals of all sizes were met with amongst grass and leaves near a stump. When gathered, every part of the cap became blood-red on the slightest bruising, the injured part later turning black. The youngest plants showed a stalk with, for pileus, a small 'bleeding' knob. The cap was brown, knobby, velutinate and zoned, some of the zones being reddish-purple, others a dark blue grey, and others yellow-brown. The stem was central to lateral, brown, velutinate and irregular. The pores were soft, white, with rounded dissepiments. Spores brown, apparently smooth, $9 \times 8\mu$, $10{\cdot}4 \times 8{\cdot}5\mu$ or sometimes subspherical $8{\cdot}5\mu$.

A specimen, collected at Hill Top in February 1911 had an irregular stem about 7 ins. long, and a very thin cap. We have another specimen from Mosman and one, gathered by Mr. A. A. Hamilton, from Lilyvale (April, 1912). Also one from Mount Wilson (June 1915), and one from Tuggerah (October, 1914. Spores smooth, $10{\cdot}4$ to $12 \times 8{\cdot}5$ to $10{\cdot}4\mu$).

In addition to these adult forms, we have two young specimens from Lilyvale, N.S.W. (April, 1912), with knobby flattened pilei under $\frac{1}{2}$ in. across, and thick-walled pallid pores. Spores $8{\cdot}5$ to $9 \times 7{\cdot}5\mu$, smooth. A still younger form (stem 1 in., pileus $\frac{1}{4}$ in.), resembling a thick-headed nail in shape, was taken by one of us (J.B.C.) under trees at Bulli in April 1914. It was woody with a brown convex cap and very shallow white pores. Stem brown, slightly hollow with a spongy centre. It was 'adherent to a small brown pea-sized body, containing cavities and enclosing a white area like a bulb.

Section 6. Polyporus. Spores distinctly rough. Stem slender, usually mesopodal.

a. Stipe smooth, non-laccate surface. No Australian species recorded.

b. Stipe with a smooth, laccate crust.

6. POLYPORUS (AMAURODERMUS) LEPTOPUS, Persoon(?).

Cooke records *Fomes nigripes* (No. 668) for New South Wales. Lloyd has been unable to find the type of *Amaurodermus nigripes* described by Fries from Brazil, and states that the description of it reads much like *A. leptopus*, under which heading we place it, though possibly the Australian record belongs to neither.

LACCOCEPHALUM BASILAPILOIDES McAlpine and Tepper.

Lloyd suggests that the "stone-making fungus" described by McAlpine and Tepper as *Laccocephalum basilapiloides* is referable to this division. On examination of the type, we find that it is closely allied to *Polyporus tumulosus* of the Division *Ovinus* (which see).

Section 7. Polystictus. Plants with thin pilei and pore layers. No Australian species recorded.

Fourth Division—LIGNOSUS

Section 8. Plants which form a sclerotium. Context pale or isabelline. Spores probably white.

No Australian species recorded.

Section 9. Pilei unilateral and superimposed. Context pale.

7. POLYPORUS (LIGNOSUS) SUPERPOSITUS Berk.

Under *Fomes superpositus* (No. 674) Cooke records this species for New South Wales. We have not met with it and it is evidently rare.

Section 10. Stipe mesopodal or pleuropodal. Context white or pale. Spores white.

No Australian species recorded.

Section 11. Context brown or gilvous. Spores white (probably).

8. Polyporus (Lignosus) scopulosus Berk.

Cooke (No. 714) gives this species for Queensland.

Fifth Division—PETALOIDES.

Section 12. Carnosus. Fleshy, soft, thick species.

9. Polyporus (Petaloides) fusco-maculatus Bresadola.

Under *P. glutinifer*, Lloyd says that a single, sliced specimen exists at Kew which is probably the same as *P. fusco-maculatus.* It was described by Cooke and was said to have come from Mauritius, but Lloyd thinks it probably came from Australia.

Section 13. Polyporus. Fleshy, thin species, colour white or pale. Pores small.

10. Polyporus (Petaloides) annulatus Junghuhn.

We have a small pure white somewhat fan-shaped species, $\frac{3}{4}$ in. in diameter, with a very short stem expanded into a disc. It resembles Lloyd's figure of *P. annulatus.* In drying, it became a pale fawn with a darker edge. The pores are small and dissepiments thin. The spores are elongated, 7 to 8·5 $\times$ 3μ. Bulli Pass, April, 1914.

11. Polyporus (Petaloides) rhipidium Berk.

This is a small white species, about $\frac{1}{4}$ in. in diameter, often found in numbers on the bark of living trees. Under *Favolus rhipidium*, this species is given by Cooke for Victoria, Queensland and New South Wales. Lloyd considers that *P. diminutus*, Massee, recorded for Australia, of which the type is not preserved, is from the figure and description founded on this species. *P. nanus* Massee, from Australia, is also *P. rhipidium.*

This species is common near Sydney on the trunks of Eucalypts (we have frequently taken it from that of *E.*

piperita). The size is rarely larger than $\frac{1}{4}$ in. and the colour almost pure white when gathered. Spores 4·4 to 5·2 × 2 to 2·5μ, white. Sydney; Terrigal (June, 1914); The Oaks (June, 1914); National Park (July, 1916). The following specimens are in the National Herbarium, Sydney:—Peakhurst (E. C., Dec., 1898); Bulli Pass (E. C., March, 1907); Narrabeen (E. C., Nov., 1908); Bowral (E. C., Aug., 1908); Cook's River (A. A. Hamilton, July, 1909); Nepean River (W. Craigie, Oct., 1909); Lane Cove (A. A. H., Aug., 1909); Helensburgh (W. C., Aug., 1909); Leura (A. A. H., Aug., 1908); Gladesville (Miss M. Flockton, May, 1900); Cheltenham (A. A. H., May, 1910); Thornleigh (E. C., Aug., 1910); Leura (T. Steel, Feb., 1911); Gosford (A. A. H., Aug., 1912); Lilyvale (A. A. H., April, 1912); Botanic Gardens (E. Bennett, June, 1913).

Section 14. Polyporus. Fleshy, thin species. Colour white or pale. Pores large, favoloid.

No Australian species recorded.

Section 15. Polyporus. Thin, rigid. Colour pale rose or reddish-brown. Not zonate or only faintly zonate.

12. POLYPORUS (PETALOIDES) RUBIDUS Berk.

Cooke (No. 640) records this species for Queensland and New South Wales.

13. POLYPORUS (PETALOIDES) BRUNNEOLUS Berk.

Cooke (No. 743) records this species for Queensland.

14. POLYPORUS (PETALOIDES) PETALODES Berk.

Recorded by Cooke (No. 613 bis) for Victoria.

Section 16. Polyporus. Thin, rigid. Strongly zonate, with greyish zones.

15. POLYPORUS (PETALOIDES) GALLO-PAVONIS Berk.

Recorded by Cooke (No. 756) for Queensland. *Polyporus subzonalis* Cooke (No. 661) Lloyd says is a pale form of this.

Section 17. Pileus yellowish-brown, gilvous. Hyphæ deep-yellow under the microscope.

No Australian species recorded.

Section 18. Grammocephalus group. Pileus marked with raised lines.

16. Polyporus (Petaloides) grammocephalus Berk.

Lloyd states that *P. muelleri* Kalchbrenner, described from Australia, is this species or a form of it. Cooke (No. 614) also places this fungus as a variety under *P. grammocephalus*, recording it from New South Wales. Cooke gives the typical form for Queensland and New Guinea and var. *Emerici* for the same places. Lloyd in referring to *P. Emerici* from India, says it is like the type of *grammocephalus* but the pores are larger. Lloyd has identified for us a specimen of *P. grammocephalus* from Mummulgum Brush near Casino, Dec., 1916. He adds that the size of the pores is variable.

17. Polyporus (Petaloides) platotis Berk.

Cooke (No. 615) says this is apparently only an abnormal distorted condition of *P. grammocephalus*. Lloyd says that from the colour, surface and pores it seems to be a *thick grammocephalus*, "but is much too thick, and apparently does not belong to the section."

18. Polyporus (Petaloides) fusco-lineatus Berk.

This is given by Cooke (No. 617) for Queensland. Lloyd says it is an obese form of *grammocephalus* with larger pores.

19. Polyporus (Petaloides) dorcadideus Berk.

Cooke, (No. 616). Recorded for Queensland.

Section 19. Polyporus. Species dark coloured, almost black at least when dry.

a. Setæfera.

20. Polyporus (Petaloides) megalosporus Mont.

C. G. Lloyd (Mycol. Notes, No. 48, 1917, p. 684) thus describes a specimen forwarded by one of us:—'Pileus suborbicular, 2 – 3 cm., laterally attached by a short stipe-like base. Colour pale alutaceous. Surface with patches of brown branched hairs. Context and pore tissue pale alutaceous. Pores large, round or slightly elongated, about ½ mm. in diameter. The pore mouths bear brown branched setæ. Spores 6 × 12μ, cylindrical, elliptical, hyaline, transparent, guttulate, smooth.' Lloyd adds that the species is usually much larger and of a darker colour. Our plants were obtained at Wingham Brush (January, 1917. Spores by our measurements 8·5 to 10·4 × 5·5μ).

b. Without setæ.

21. POLYPORUS (PETALOIDES) OBNIGER Lloyd.

Lloyd (Mycol. Notes, No. 45, 1917, p. 632) thus describes the specimen received from Dr. F. Stoward of Western Australia:—'Pileus (about 2 × 3 × 7 cm.) with a short lateral stipe, thick, rigid. Surface smooth, black. Context pale isabelline. Pores minute, round, with greyish cinereous mouths (when dry), decurrent to base of stem. Cystidia none. Spores not found.'

Section 20. Polyporus. Coloured context and spores. Included under Ganodermus.

Section 21. Aberrant species forming "new genera."

22. POLYPORUS (PETALOIDES) POCULA Schweinitz.

Lloyd says this species occurs in Australia. Cooke records *P. cupuliformis* (No. 590) for Victoria, which Lloyd says is *P. pocula.*

Section 22. Polystictus. Pileus pale, usually spathulate or flabelliform, thin. Pores in a thin layer, white or pale, minute.

23. POLYSTICTUS (PETALOIDES) MUTABILIS Berk.

Cooke (No. 736) gives this species for Queensland.

24. Polystictus (Petaloides) obovatus Junghuhn.

Cooke gives *Polystictus Adami* (No. 735) = *Polyporus dilatatus* (sic) Berk. Lloyd points out that *P. Adami* and *P. dilatus* are really *P. obovatus*, as is *P. rasipes* (Cooke, No. 747).

25. Polystictus (Petaloides) stereinus Berk.

Cooke (No. 741) gives this species, which he says equals *P. cognatus* Kalchb., for Queensland and New South Wales. We have specimens, identified by Lloyd, from Mount Irvine (June) and Mount Wilson (June—spores 4·8 to 5·6 $\times$ 2·5μ); also from Leura, June.

Section 23. Polystictus. Microporus. Lateral stem.

26. Polystictus (Petaloides) affinis Nees.

Cooke (No. 740) records the species for Queensland and New South Wales.

27. Polystictus (Petaloides) luteus Nees.

Cooke (No. 737) gives this species for the same two States. Lloyd says it runs into *P. affinis*. Lloyd thinks that *P. porphyritis* (Cooke, No. 734) is probably the same as *P. luteus*. Cooke gives this form for Queensland. *P. carneo-niger* (Cooke, No. 738) Lloyd says has the same characters as *P. luteus*, except its black colour.

28. Polystictus (Petaloides) flabelliformis Klotzsch.

Cooke (No. 733) records this for Victoria, New South Wales and Queensland. Lloyd has identified specimens for us from Mummulgum Brush near Casino (December, 1916). These were found growing in company with typical *P. xanthopus*, into which, as Lloyd has remarked to us, it seems to run. We also have it from near Wauchope (February, 1916).

Section 24. Polyporus (corresponding to Polystictus but thicker) with colour and pores of the section Microporus.

29. Polyporus (Petaloides) subfulvus Berk.

Lloyd has identified for us, at first with some doubt, three collections. The localities of two of these are not noted, the third was from Leura (June, 1916). The specimens are in most part resupinate with a raised edge.

Section 25. Red Species.

30. Polystictus (Petaloides) sanguineus Linn.

The common and beautiful vermilion-coloured leathery fungi so frequently found throughout Australia on fallen logs and sticks are referable to the species *P. sanguineus* and *P. cinnabarinus*. They materially assist, by their penetrating mycelium, in the decay of the substance on which they grow; though this is usually worthless material, occasionally useful timber is also attacked. In colour and general appearance these two species are identical, the only difference being that the former is much thinner and contracted with a short lateral stem-like base, whilst the latter has generally a broad attachment. In the neighbourhood of Sydney, typical instances of both forms may be met with, though the latter is more common. Since *P. sanguineus* is the tropical species and the other the temperate one, the occurrence of both might be expected in this area, the thinner form being met with in sheltered areas, especially in swamps, where moisture is abundant. So close is the resemblance between the two, that we referred the question of their being merely varieties of one species to C. G. Lloyd. In his reply he states that he considers them entitled to separate names, although they are really only the tropical and temperate forms of the same species. He adds that he rarely has difficulty in classifying specimens from various parts of the world, except in the case of occasional specimens from districts which may be classed as between the tropics and the temperate regions.

Compared with specimens kindly forwarded by Lloyd, we have typical examples of *P. sanguineus*, growing on fallen logs, from Laurieton, Tuggerah (spores 4·4 to 5·5 × 2·2μ), Terrigal and Berry (spores slightly curved, 5·2 to 6 × 2μ). Most of the specimens from the immediate neighbourhood of Sydney approach more to the *P. sanguineus* type than to *P. cinnabarinus*, but specimens collected at Wellington, Bumberry and Forbes, in the dry west of this state, and at Adelaide, are definitely *P. cinnabarinus*. We have also got *P. cinnabarinus* at Kew (May) which is close to Laurieton where we got *P. sanguineus*.

The following specimens of *P. sanguineus* are in the National Herbarium, Sydney:—Atherton, Q. (E. Betche, September, 1901); Eumundi, Q. (J. Staer, September, 1912); North Queensland (Rev. W. W. Watts, July, 1913); Lord Howe Island (Rev. W. W. Watts, July, 1911); Russell Island, Solomon Group (W. W. Froggatt); Naru Island, Ocean Island Group (F. W. Steel, June, 1908); Funafuti (Mr. Finckh, 1898); New Hebrides (W. T. Quaife, May, 1903 and W. W. Froggatt, July, 1913); Wahroonga (Staer, July, 1910), a specimen sent to Lloyd, more thick and obese than usual. Cooke (No. 746) records it for all the States.

These two species may be found almost at any time of the year after sufficient rain on fallen logs.

31. Polystictus cinnabarinus Jacquin.

This is the thicker vermilion species usually found in the cooler parts of Australia. As it is without a stem, it does not strictly belong here, but is so placed by Lloyd on account of its affinity with *P. sanguineus*. Amongst over fifty collections in the National Herbarium, Sydney, the following localities are represented:—Sydney district, Kahibah near Newcastle, Smoky Cape, Upper Hastings, Bulli district, Hill Top, Nepean, Richmond, Blue Mountains, Bathurst, Cobar, Nyngan, Brewarrina, Inverell, Hillgrove,

Pilliga, Kangaroo Valley, Wamberal, Burrenjuck, Mount Jellore viâ Mittagong, Rockhampton (Q.), Adelaide (S.A.), Western Australia. The hosts comprise:—*Melaleuca styphelioides*, *M. parviflora*, nectarine, peachtree (dead limbs), and dead Banksia (Sydney district); red box (Nyngan); decayed ironbark (Conjola); and dead jarrah (Bow River), W.A.

Section 26. Polystictus. White species.

No Australian species recorded.

Other species of Petaloides.

32. Polystictus (Petaloides) pentzhei Kalch.

This was unknown to Lloyd.

33. Polystictus (Petaloides) intonsus Berk.

Cooke, No. 742. The type from Tasmania does not exist (Lloyd).

34. Polystictus (Petaloides) peroxydatus Berk.

Cooke, No. 744. The type from New South Wales does not exist (Lloyd).

35. Polystictus (Petaloides) libum Berk.

Cooke, No. 745. Queensland, New South Wales. Lloyd says the type is inadequate.

36. Polystictus (Petaloides) verniciflus Berk.

Cooke, No. 790, Queensland, Tasmania. The type is inadequate (Lloyd).

Sixth Division—MERISMUS.

Section 27. Spores globose, echinulate.

37. Polyporus (Merismus) Berkeleyi Fries.

'Pilei imbricate, arising from a short, thick stem or root stalk. Surface pale, dull, slightly tomentose and obscurely zoned. Context $\frac{1}{2}$ to 1 in. thick, white. Spores globose, 8μ, distinctly echinulate.'—Lloyd.

We have found this large and handsome species, of which Lloyd has identified specimens, growing near the base of trunks in the Lisarow district in May 1915 and June 1916. The caps are buffy to bright yellowish tan, velvety to strigose, obscurely but definitely zoned, the growing edges velvety and rolled over. The pores are rather irregular and creamy white. The caps arise from an irregular base as somewhat stipitate, superimposed brackets. The flesh is white, somewhat brownish under the crust; it is rather juicy and the juice milky. Spores white, warty, 7μ.

Section 28. Spores smooth, hyaline. Plants fleshy.

38. POLYPORUS (MERISMUS) FRONDOSUS Fl. Dan.

Cooke (No. 618) records the species for Tasmania.

39. POLYPORUS (MERISMUS) ANTHRACOPHILUS Cooke.

Lloyd says that this species is only known from one or two collections at Kew from Australia. Cooke, No. 622, lists it for Victoria, Queensland and South West Australia.

40. POLYPORUS (MERISMUS) MULTIPLEX Berk.

Lloyd says this fungus is known from a single specimen at Kew from Mueller, Australia, a description of which he believes was never formally published.

Section 29. Merismus—Polystictus. Thin plants having the habits of the section Merismus.

41. POLYSTICTUS (MERISMUS) RIDLEYI Massee.

Lloyd mentions that this is known from one collection at Kew from Tasmania.

Section 30. Merismus caseosus.

42. POLYPORUS (MERISMUS) SULPHUREUS Fries.

Recorded by Cooke (No. 624) for Queensland and Tasmania.

42a. Polyporus (Merismus) sulphureus var. Wilsonianus Lloyd.

Lloyd (Letter 53, 1914, Note 179) records *P. Wilsonianus*, a form of *P. sulphureus*, from the Rev. James Wilson, Victoria. He states it differs from typical *P. sulphureus* in the very thin flesh, 1—2 mm. thick, and in the piriform not globose spores.

43. Polyporus (Merismus) retiporus Cooke.

Cooke (No. 625) gives this species for Victoria and Queensland. Wakefield (Kew Bull., 1914, p. 157) says that specimens in Kew Herbarium from Victoria labelled *P. retiporus* are *P. australiensis* (which see, Sect. Apus, Polyporus). The acceptance of this as an Australian species should therefore be received with doubt. Lloyd says it is like *P. sulphureus*, but with larger pores and firmer context, and thinks it will prove to be only a form of this species.

[1][44. Polyporus (Merismus) intybaceous Fries.

Cooke, No. 619. Not mentioned by Lloyd.

[1]45. Polyporus (Merismus) scabriusculus Fries.

Cooke (No. 621) records this for Australia. Lloyd says no type exists.

[1]46. Polyporus (Merismus) lætus Cooke.

Cooke (No. 623). Not mentioned by Lloyd.]

Section 31. Conglobatus carnosus. No Australian species recorded.

Section 32. Conglobatus, Fomes. No Australian species recorded.

Section 32a. Merismatoid.

47. Polyporus rosettus Lloyd.

'Submerismatoid. Proceeding from a hard, woody base, it divides into a number of short, irregular lobes. Pores

[1] Position under Section unknown.

small, round, irregular, white. Context very hard, white. Surface fuliginous. Spores 5 × 3μ, hyaline, piriform.' Described from Australian specimens by Lloyd (Mycol. Notes, No. 43, 1916, p. 601).

Specimens have been identified for us by Lloyd. We have found it growing as a large mass at the burnt base of a dead tree at Katoomba in June, 1916 (spores 4·8 × 2·5 to 3·5μ). We have also specimens on burnt wood from Mount Wilson in June, 1915 (spores 4 to 5 × 2·5 to 3·4μ).

Seventh Division—SPONGIOSUS.

Section 33. Context pale or white. Spores white.

48. POLYPORUS (SPONGIOSUS) RUFESCENS Persoon.

Cooke (No. 600) records the species for Victoria, Queensland and Western Australia. *P. biennis*, recorded by Cooke (No. 599) for Queensland, and *P. proteiporus* (No. 601) also given by Cooke for the same State, are both, Lloyd states, *P. rufescens.*

49. POLYPORUS (SPONGIOSUS) HYSTRICULUS Cooke.

Cooke (No. 620) records this for Victoria. Known from a single specimen at Kew (Lloyd).

Section 34. Context deeply coloured. Spores supposed to be white.

50. POLYPORUS (SPONGIOSUS) SCHWEINITZII Fries.

This species is parasitic on the roots at the bases of tree trunks, and is said to be a destructive parasite. It may be readily recognised by its irregular cap, sometimes four or more inches across, which is rugged and has a bright ferruginous colour. The stem is sometimes very short, sometimes several inches long, rugged and irregular and dark ferruginous brown. The pores are rather small, run down on to the stem and are greyish-yellow. Often the caps of several adjacent plants grow into each other.

Cooke (No. 597) gives this polypore for Queensland. Lloyd says *P. tabulæformis* (Cooke, No. 598, Queensland) is the same species. We have the following collections:—Grafton (April, 1912); Lisarow (May, 1915); Terrigal (June, 1914); Sydney; at base of living *Angophora lanceolata*, Sydney (March); National Park (July); near Wauchope (February). Spores spherical to oval, $3{\cdot}5\mu$, $5{\cdot}2 \times 3{\cdot}5\mu$. Milson Island, Hawkesbury River, specimens (April, 1915) have spores irregularly spherical, $3{\cdot}4$ to $4{\cdot}2\mu$, whilst those of the Lisarow ones are $7 \times 5{\cdot}2\mu$. The pores do not seem large and the orifices are pallid greyish.

One of our specimens was sent to Lloyd who says:—'My first impression was that it was not *P. Schweinitzii*, but on comparing it, I do not note any real difference. The pores are smaller. It does not colour potash solution yellow as does *P. Schweinitzii*, and the appearance of the pore tissue is not the same under the microscope. Still I would not know how to point out any real difference. It is the first specimen I have from Australia. With us it is usually in pine-woods.'

Section 35. Context deeply coloured. Spores coloured, but often faintly.

51. POLYSTICTUS (SPONGIOSUS) TOMENTOSUS Fries.

Recorded by Cooke (No. 724) for Victoria and Queensland.

Eighth Division—PELLOPORUS.

Section 36. Pelloporus Polyporus. Context fleshy, tough, rather brittle, mostly more obese than the next section.

52. POLYPORUS (PELLOPORUS) LUTEO-NITIDUS Berk.

Recorded in Cooke (No. 725) for Queensland.

Section 37. Pelloporus Polystictus. Context thin, flexible.

53. POLYSTICTUS (PELLOPORUS) PERENNIS Linn.

Given by Cooke (No. 726) for Queensland.

54. Polystictus (Pelloporus) oblectans Berk.

Lloyd considers that the Australian plant is specifically distinct from *P. cinnamoneus* which it closely resembles, but differs in having large pores and more erect fibrils on the pileus. Cooke (No. 728) gives *P. oblectans* for Victoria, Queensland, Western Australia and Tasmania. In view of what Lloyd says, the record of *P. cinnamoneus* for 'Australia' (Cooke, No. 727) had better be considered a misidentification for *P. oblectans.* Lloyd says that Fries considered *P. bulbipes* (Cooke, No. 729 = *P. cladonia* Berk., and *P. perdurus* Kalch.) to be *P. oblectans.* Cooke's record of *P. parvulus* (No. 730) for Victoria must also be considered that of a synonym (Lloyd).

This small pliable (when fresh) cinnamon-coloured polypore is common in the Sydney district in autumn, especially in sandy soil (April). We make the spores pale brownish, 7 to 7·3 × 5·2μ (Lloyd gives 8 × 5μ). We have it also from the Blue Mountains (April) and Bumberry (Oct.); also from Ararat, Victoria (E. J. Semmens, No. 5).

The following collections are in the National Herbarium, Sydney:—Parramatta (E. C., March, 1908); Upper Lane Cove (Miss P. Clarke, 1913); Cheltenham (E.C., and A. A. Hamilton, Feb., 1911); Gladesville (Miss M. Flockton, Feb., 1911); Cook's River (A.A.H., June, 1908); Neutral Bay (J.B.C., May, 1910); Hill Top (E.C., Feb., March); Lawson (D. Wiles, 1912); Leura (A.A.H., March and T. Steel, Feb.); Scarborough (A.A.H., May, 1913); Milson Island, Hawkesbury River (J.B.C., July, 1912).

Specimens obtained at Mount Lofty, South Australia, in July 1914, by one of us, have slightly stouter stems than is usual in New South Wales specimens, and some collected by us in Western Australia have this character still more pronounced and the pileus not so silky-looking.

Ninth Division—OVINUS.

Section 38. With sclerotium.

[We propose to deal more fully with the Australian species in this section in a separate paper.]

55. POLYPORUS (OVINUS) MYLITTÆ Cooke.

This Polyporus is the fruiting body of the well-known 'Native Bread' and has been rarely seen. The 'Native Bread' itself is commoner and consists of a large rounded mass of fungal hyphæ often several pounds in weight. From this buried mass, when favourable opportunities arise, the fruiting bodies develop and appear above ground.

56. POLYPORUS (OVINUS) MINOR-MYLITTÆ (Berk.)

A smaller form of 'Native Bread,' referred to by Berkeley as '*Mylitta minor*,' has fruiting bodies with dark brown caps, very different in appearance from the white and 'yolk of egg' ones of the larger Mylitta. We propose to distinguish it as above by Berkeley's name. It is not uncommon in New South Wales.

57. POLYPORUS (OVINUS?) BASILAPILOIDES McAlpine & Tepper.

The 'stone-making fungus,' described by McAlpine and Tepper as '*Laccocephalum basilapiloides*,' and from the description doubtfully referred by Lloyd to the Division *Amaurodermus*, is from an examination of the type made by us certainly not an *Amaurodermus*, having elongated, smooth, white spores. It is probably referable to *Ovinus*, and from its false sclerotium to this section.

Section 39. Stipe usually mesopodal. Pores small.

58. POLYPORUS (OVINUS) OVINUS Schaeffer.

Recorded by Cooke (No. 583) for Victoria.

Section 40. Stipe central. Pores large.

No Australian species recorded.

Section 41. Stipe usually excentric or irregular. Pores small.

59. Polyporus (Ovinus) confluens Albertini.

Cooke (No. 620) records the species for Queensland and Lord Howe Island.

Section 42. Stipe excentric. Pores large.

60. Polyporus (Ovinus) pes-capræ Persoon.

Cooke (No. 584) records it for Victoria.

Section 43. Melanopus. Pores large.

61. Polyporus (Ovinus) squamosus Fries.

Cooke (No. 603) records it for Queensland. *Favolus Boncheanus* Klotsch (Cooke, No. 896, Queensland) is a 'small smoothish form of squamosus with uncoloured stipes' —Lloyd.

A specimen growing on wood obtained by Miss P. Clarke at Chatswood, in April, 1914, we are referring to this species though uncertain about it. The edge of the pileus is thin, irregular and reflexed. The surface is earthy-brown and covered with small scurfy scales. The pores are minute, very shallow, whitish and decurrent on to the almost central dark brown tomentose stem. The whole is somewhat flabelliform and slightly depressed, 2½ ins. broad and about the same in height.

Lloyd (Letter 53, 1914, Note 174) records a specimen from J. Simmonds, Australia. It differed from European examples in having smaller, innate scales and in the stem not being black.

61a. Polyporus (Ovinus) squamosus var. lentinoides (*P. lentinoides* Hennings).

In March, 1914, one of us collected on burnt ground at Milson Island, Hawkesbury River, N.S.W., a large stipitate polypore 6 ins. in diameter, growing deeply and possibly attached to an underground root. The pileus was slightly convex, reddish tan and smooth. The flesh was thick (¾ in.), white and rather soft and spongy. The pores, ⅜ in.

deep, were lacerated, thin and pure white or slightly creamy. There was a more or less central stipe 3 ins. long and $1\frac{1}{4}$ ins. thick, apparently whitish but covered with adherent sandy dirt. From the base arose a slender secondary stem bearing a small deformed pileus attached to the larger one; the spores were elongated, white, $8{\cdot}6$ to $10{\cdot}4 \times 3{\cdot}8\mu$. Lloyd has kindly identified this as *Polyporus lentinoides* Henn., originally from Brazil. He adds:—"In reality only a scaleless form of *Polyporus squamosus* with which it agrees in all particulars excepting the scales. Practically the same plant, but a little more fleshy, is known in Europe as *Polyporus Roskovii* Fr."

62. POLYPORUS (OVINUS) TUMULOSUS Cooke.

Given by Cooke (No. 586) for Queensland.

63. POLYPORUS (OVINUS) TASMANICUS Massee.

Known from one collection from Tasmania at Kew (Lloyd). We have a specimen collected at Neutral Bay, Sydney (March, 1915).

Section 44. Melanopus. Pores small.

64. POLYPORUS (OVINUS) HARTMANNI Cooke.

This is a thick, fleshy polypore with a rich somewhat chestnut-brown, rather velvety cap, and a short thick stem attached excentrically and not centrally, which is also dark brown and velvety. It is found growing near the base of trees, and appears to be parasitic and of some importance from a forestry point of view.

Cooke (No. 585) gives this species for Queensland.

We obtained a clump of this species on the ground at Bulli Pass, N.S.W., in April 1914. The largest were 3 ins. in diameter with an excentric stipe. The pores were minute and whitish. Our specimens agree exactly with the description given by Lloyd, but the spores are 7 to $8{\cdot}5 \times 3{\cdot}5\,\mu$, whilst he gives them as $12 \times 5\,\mu$. Lloyd has kindly confirmed their identification for us.

We have also specimens from Gladesville (M. Flockton, determined by Lloyd who gives the spore as elongated, 5 × 12 μ, hyaline, smooth); Wamberal (E.C., April, 1912); Jellore Creek, viâ Mittagong, on roots of Eucalyptus (E.C., April, 1916).

[1][65. POLYPORUS (OVINUS) MYELODES (*P. myclodes*, err. typ.) Kalch.

Unknown to Lloyd. Cooke (No. 587) records it for Queensland.]

Tenth Division—LENTUS.

Section 45. Lentus. Pores small.

(*a*) White.

66. POLYPORUS (LENTUS) TRICHOLOMA Montague.

Cooke (No. 592) gives this for Queensland. As regards *L. similis* (Cooke, No. 593), Lloyd says the type is very scanty, but is probably this species. *Polyporus stipitarius* is *L. tricholoma* (Lloyd). He says that *P. Armitii*, referred by Cooke to *P. stipitarius*, is surely not so if the figure in "Grevillea" is at all like it. No type of *P. Armitii* exists.

(*b*) Greyish or fuliginous brown.

67. POLYPORUS (LENTUS) BRUMALIS Pers.

Cooke (No. 589) gives this species for Queensland.

(*c*) Colour yellow or reddish-brown.

68. POLYPORUS (LENTUS) VIRGATUS Berk.

We have specimens, identified by Lloyd, found on a fallen trunk at Lisarow in June, 1916.

(*d*) Microporus. Thin, rigid, with minute white pores in a very thin layer. Colour reddish-bay or sienna brown.

69. POLYPORUS (LENTUS) XANTHOPUS Fries.

Cooke (No. 732) records this for Victoria, New South Wales, Queensland and New Guinea. *L. cupreonitens* is a

[1] Position under Section unknown.

synonym. Lloyd says that no type exists of *P. quadrans* Berk. (Cooke, No. 731) which from the description seems to be *L. xanthopus*. We have specimens of a variety of *L. xanthopus* from Melville Island, Northern Territory (W. S. Campbell, 1911) which possibly is *L. quadrans*. They resemble a very short-stemmed *L. xanthopus* in all particulars, save that the pores are a dark fawn to cinnamon. The margin of the pileus is pale, not brown as should be the case with *L. quadrans*.

We have typical forms from the Northern Territory (*per* South Australian Museum); Eumundi, Q. (J. Staer, 1911); Atherton near Cairns, Q. (E. Betche, 1901 and R. Mitchell, 1911); Kuranda near Cairns (A. J. Vogan, 1910); Barron Falls, Q. (Mrs. Fraser, Sep., 1917); Rockhampton, Q. (D. Dixon); between Cooktown and Cairns (W. Seymour); Marshall Falls, Alstonville, N.S.W. (D. Tanner, Sep., 1911); Mummulgum Brush near Casino (J.B.C., Dec., 1916, growing in company with *Polystictus flabelliformis*, both identified by Lloyd); Port Moresby, New Guinea (Mr. Pratt, 1911); Russell Island, Solomons (W. W. Froggatt, 1909).

70. POLYPORUS (LENTUS) ARCULARIUS Batsch.

This is a common species, found growing on fallen logs and half-buried pieces of wood. Beyond assisting in disintegrating fallen timber, it is of no importance from a forestry point of view. It has usually a yellow-brown cap, up to 1½ ins. in diameter, depressed in the centre and sometimes slightly scaly, the pores are large, and the stem is central, slender, and coloured like the cap.

Recorded by Cooke (No. 591) for Victoria, New South Wales and Queensland. Lloyd says that *Favolus squamifer* Berk. (Cooke, No. 895) is close to, if not the same as, *L. arcularius*. *Polyporus alveolarius* (Cooke, No. 594) Lloyd says, from the figure, is *L. arcularius*. Of *P. collybioides* Kalch., recorded for Australia, Lloyd says the type is in-

adequate, and Cooke says it is synonymous with *P. alveolarius* (i.e. *L. arcularius*).

This species is fairly common round Sydney and the Hawkesbury River district (records from January to March and August to December). The largest specimen we have measures $1\frac{1}{2}$ ins. across. In some, the scales of the pileus are very dark, as is the stem. Spores white, elongated, ends rather pointed, 7·2 to 8 × 2 to 3·4μ. Also on living trunks of *Eucalyptus rostrata*, Moree, January, 1917; Narrabri, November (spores 8 × 5μ); Mount Irwin (Darnell-Smith), January, 1915; Flinders Island, Bass Straits, November, 1912.

The following collections are in the National Herbarium, Sydney:—Helensburgh (A. A. Hamilton, October, 1913); Penshurst, (E. Cheel, February, 1908, January, 1911); Botanic Gardens (E. Cheel, December, 1907), on trunk of *Ligustrum sinensis;* Randwick (R. Nichol, March, 1910); Narrabeen (E. Cheel, November, 1908); Schofields (E. Cheel, December, 1908); Cook's River (A. A. Hamilton, March, 1909); near Dubbo (J. B. Cleland, September, 1911); St. Mary's (A. A. Hamilton, August, 1910); Kogarah (E. Cheel, October, 1909); Rookwood (Miss A. Spencer, July, 1910); National Park (F. Hallman, November, 1908).

71. Polyporus (Lentus) lentus Berk.

Cooke (No. 588) records this for Victoria.

Section 46. Lentus. Subgelatinous when fresh (tending towards Laschia). No species recorded for Australia.

Section 47. Lentus. Aberrant species as to shape. Infundibuliform, gibbous or very minute. No species recorded for Australia.

Of *Polyporus pisiformis* Kalchbrenner, Australia, (Cooke, No. 596, Victoria), Lloyd says:—" 'Type' is a little incipient sessile undeveloped pad, about the size and appear-

ance of a wart. Should never have been named at all, and most certainly should never have been put in the section of Lentus of *stipitate* fungi where Cooke placed it."

Eleventh Division—MELANOPUS.

Section 48. Stipe pleuropodal or central, rarely lateral. Pores minute.

72. Polyporus (Melanopus) varius Pers.

Lloyd has identified for us specimens from Mummulgum Brush near Casino (December, 1918). These plants are larger (2 ins. across) and stouter than our common *P. Pancheri.* The cap is of a brownish tan and slightly striate, the pores are pallid whitish.

72a. Polyporus (Melanopus) varius var. Blanchetianus Mont.

Lloyd considers this a small form of *P. varius*, and has identified as *P. Blanchetianus* specimens from Miss M. Flockton from Port Jackson.

72b. Polyporus (Melanopus) varius var. Pancheri Patouillard.

Lloyd says that this and seven other 'species' might easily be considered as forms of *M. varius* (Cooke, No. 608). *M. picipes* (Cooke, No. 605) is a black form of *M. varius* with a velvety stem. *M. dictyopus* (Cooke, No. 613) is the typical smaller form of *M. varius-picipes*, usually known as *M. infernalis* of Berkeley (Cooke, No. 607), to which latter the Australian form, *M. Pancheri*, is referred at Kew. Of *Polyporus Strangeri* Kalch., Lloyd says that the type is unknown, but from the description it seems to be *M. dictyopus* (i.e. *M. Pancheri). M. elegans* (Cooke, No. 609) is another variety with such a constant smaller size that it is generally held to be a good species (Lloyd). From these remarks of Lloyd, it seems best, at present at any rate, to consider all these Australian records as belonging to the

one species (or a variety of one species) and to refer them to *M. Pancheri* (or *M. varius* var. *Pancheri*) pending the examination and comparison of further material.

This is a small species, occasionally with a cap as large as 1½ inches across, growing on the ground usually attached to buried sticks or wood. Though some specimens are white or pale coloured, the cap and stem are usually a dark sooty brown, the former being somewhat striate, whilst the pores are minute and white or pallid.

Our Australian specimens vary considerably amongst themselves. The stipe, even in specimens taken together, varies from about central to quite lateral. The other points of difference affect more colonies than individuals. The colour of the cap varies from almost black through a dark greyish-brown to a lighter greyish-fawn, and is in one specimen a dark chestnut. In several, the plants were at first pure white, later becoming pale stony-brown. The striations are more or less in evidence. The pores are usually 5·2 to 8 × 2·5 to 3μ, in the chestnut-coloured specimen being 3·5 to 5 × 2μ. Growing usually attached to buried pieces of wood (in this resembling *M. melanopus*). Sydney district, common (January, March to June); Bulli (April); Hawkesbury River; Lisarow (June)—all in New South Wales. Mount Lofty, S.A. In the National Herbarium, Sydney, there are specimens from the following localities:—Longueville, on dead stump (E.C., May, 1909); Leura (A. A. Hamilton, March, 1910, and T. Steel, Feb., 1911); Mosman (A.A.H., May, 1912); Hill Top (E.C., July, 1915); Gladesville (Miss M. Flockton, April, 1916).

73. POLYPORUS (MELANOPUS) MELANOPUS Schumann.

Cooke (No. 604) records this for Victoria and Queensland.

Section 49. Stipe pleuropodal or central. Pores medium. No Australian species recorded.

Section 50. Stiple pleuropodal or central. Pores large, favoloid.

No Australian species recorded.

Section 51. Stipe lateral but the pileus is not spathulate. Pores minute.

74. Polyporus (Melanopus) nephridius Berk.

Recorded by Cooke (No. 739) for Queensland.

Section 52. Stipe lateral but pileus not spathulate. Pores medium or large.

75. Polyporus (Melanopus) pusillus Fries.

Recorded by Cooke, under *Favolus pusillus* (No. 898) for Tasmania.

Section 53. Petaloides. Stipe lateral. Pileus spathulate, tapering to the stipe.

76. Polyporus (Melanopus) Guilfoylei Berk.

Originally described from Australia. Cooke (No. 611), Queensland.

[1][77. Polyporus (Melanopus) glabratus Kalchb.

Cooke (No. 610), Victoria. The type was unknown to Lloyd.]

II. SYNOPSIS OF THE GENUS FOMES.

(According to C. G. Lloyd.)

First General Division, Pallidus. Context and pores pale, white, isabelline or pale yellowish, pale rose or cinnamon. Spores hyaline.

Section 54. Large. Context white, soft, friable.

„ 55. Large. Context white, hard.

„ 56. Small. Context white or isabelline.

„ 57. Context pale yellow.

„ 58. Context isabelline, hard.

„ 59. Context isabelline, soft, punky.

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[1] Position under Section unknown.

Section 60. Context pinkish cinnamon.

„ 61. Context cinnamon.

„ 62. Context pink or rose colour.

Second General Division, DEPALLENS.

Section 63. Pores darker than context, usually fading out in old specimens.

Third General Division, AURANTIACUS. Context orange rufous.

Section 64. Spores hyaline (or very pale coloured).

„ 65. Spores coloured.

Fourth General Division, BICOLORIS.

Section 66. With bicoloured tissue, the pores a dark brown, the flesh a light buff.

Fifth General Division, FUNALIS.

Section 67. Pileus with a thick pad of dense, brown hairs. analagous to section Funalis in *Polystictus.*

Sixth General Division, FUSCUS. Context some shade of brown, Spores not truncate.

Section 68. Setæ none. Spores hyaline.

„ 69. Setæ present. Spores hyaline.

„ 70. Setæ none. Spores coloured.

„ 71. Setæ present. Spores coloured.

Seventh General Division, GANODERMUS. Context brown. Spores truncate.

Section 72. Fomes-Ganodermus. Pores with thin walls.

„ 73. Ponderosus-Fomes-Ganodermus. Pores with thick walls.

„ 74. Stipitate Fomes of the Section Ganodermus.

First General Division—PALLIDUS.

Context and pores pale, white, isabelline, or pale yellowish, pale rose or cinnamon. Spores hyaline.

Section 54. Large. Context white, soft, friable.

No Australian species recorded.

Section 55. Large. Context white, hard.

78. Fomes connatus Fries.

Recorded by Cooke (No. 71) for Queensland.

79. Fomes annosus Fries.

Syn. *Polyporus hypopolius* Kalch., probably, (Cooke, No. 658); *Fomes contrarius* B. and C. (Cooke, No. 694).

Recorded by Cooke, under the above two synonyms, for Queensland.

Section 56. Small. Context white or isabelline.

80. Fomes Clelandii Lloyd, (Mycol. Notes, No. 40, Feb. 1916, p. 550).

"Pileus sessile, small, 1 to 2 cm. in diameter. Surface black, regular, dull. Context isabelline. Pores minute with white mouths. Cystidia none. Spores elliptical, 6 to 7 × 7 to $8\frac{1}{2}\mu$, subhyaline, opaque, smooth. When this was received it was referred with doubt (cfr. Note 297, Letter 59) to *Fomes scutellatus*, an American species, with which it exactly accords to the eye. We have since found that the spores of *Fomes scutellatus* are entirely different, and hence must re-name the Australian plant."—Lloyd. Tuggerah (J.B.C., October, 1914).

81. Fomes Ohiensis Berk.

"Pileus small, dimidiate, usually less than 2 cm. in diameter, $\frac{1}{2}$ cm. thick, white, hard. Surface smooth, even, with no distinct crust. Context and pores white. Pores small, round, regular. Spores obovate, truncate at base, hyaline, smooth, 12 to 14 × 8μ."—Lloyd.

This species is very closely allied to the common Australian *Polyporus ochroleucus* found so frequently on fence-rails. In America it is found in the same situations. Lloyd has identified for us as this species, a specimen found at Lisarow in August, 1916 (spores truncate, 10·4 to 12 × 7 to $7{\cdot}5\mu$). Except that the pores are smaller than our

specimens of *P. ochroleucus*, it very closely resembles this species.

Section 57. Context pale yellow.

82. Fomes pinicola Swartz.

Syn. *Fomes marginatus* Fr. (Cooke, No. 677)—Lloyd.

"Pileus applanate or ungulate. Surface with a thin resinous crust, at first white, soon reddish, finally black. Context pale yellow, punky, but hard. Pores minute, round. Pore layers about a cm. thick, pale yellow, harder than the context. Spores $3\frac{1}{2}$ to 4×7 to 10μ, obovate, hyaline, smooth."—Lloyd.

Recorded by Cooke as *Fomes marginatus* for Victoria and New South Wales.

Section 58. Context colour isabelline. Context hard.

83. Fomes hemitephrus Berk.

"Pileus ungulate, with dull surface, becoming dark in old specimens, with indistinct crust (orange colouration under the crust). Context hard, woody, yellowish isabelline colour. Pores minute, hard, with concolorous tissue." —Lloyd.

Recorded by Cooke (No. 711) for Victoria. Lloyd records a specimen (under *Fomes martius*), presumably from New South Wales, forwarded by W. W. Froggatt. Lloyd has identified several specimens for us. We have them from the following localities:—Mount Wilson and Mount Irvine, June, 1915 (applanate, about an inch thick, with a zonate pileus and an orange shade under the crust); Kurrajong Heights; Leura (A. A. Hamilton, September, 1912); Tuggerah Lakes (S. J. Johnston, April, 1910); Belmore Falls (E.C., September, 1907); also from Russell Falls, Tasmania (E.C., March, 1910).

Section 59. Context isabelline, soft, punky.

No Australian species recorded.

Section 60. Context pinkish cinnamon.

84. FOMES SEMITOSTUS Berk.

Syn. *Fomes tasmanicus* Berk, probably (Cooke, No. 695).

Recorded by Cooke, as above, for Tasmania.

85. FOMES DOCHMIUS Berk.

Recorded by Cooke (No. 678) for Queensland.

86. FOMES CONCAVUS Cooke.

Recorded by Cooke (No. 679) for Queensland.

Section 61. Context cinnamon.

87. FOMES FERREUS Berk.

Recorded by Cooke (No. 713) for Queensland.

Section 62. Context pink or rose colour.

88. TRAMETES CARNEA Nees.

Recorded by Cooke as *Fomes carneus* (No. 717) for Victoria, South Australia and Queensland.

89. TRAMETES FEEI Fries.

Syn. *Polystictus Feei* Fries., Epic. 476; Cooke, Handb. of Australian Fungi, No. 768. "Pileus thin, pink colour, applanate (10 to $14 \times 4\frac{1}{2}$ cm.) Surface appressed, fibrillose, with a zonate effect, glaucescent. Context thin, punky. Pores minute, round."—Lloyd.

Recorded by Cooke, as above, for all the States except South Australia.

In identifying for one of us (J.B.C.) a specimen as *Trametes Feei*, Lloyd says it "corresponds to the Brazilian plant, although the specimen is an evident Fomes." This example was over a foot wide and about 3 ins. from front to back. We have collected a similar specimen at Mount Wilson in June, 1915.

90. TRAMETES LILACINO-GILVA Berk.

Syn. *Polystictus lilacino-gilvus* Berk., Ann. Sci. Nat. III, 324; Cooke, Handb. of Aust. Fungi, No. 767. "Pileus

applanate, usually thin, rose or pink colour, with surface strongly rugose, fibrillose. Context concolorous, punky. Pores medium round, concolorous. Spores oblong, hyaline, smooth, $4 \times 8\mu$. It differs (from *T. Feei*) in having notably larger pores and more strongly fibrillose surface."—Lloyd. Recorded by Cooke for all the States except New South Wales, and South Australia. Of this common species we have many specimens, viz:—Milson Island, Hawkesbury River, (J.B.C., May, August); Terrigal (J.B.C., June, 1914) identified by Lloyd; Hill Top, (J.B.C., October, 1913) spores elongated, oblique, 7 to $8{\cdot}3 \times 3{\cdot}5\mu$—when moist pileus dark brown, radiately fibrous, then light brown, not definitely zoned, edge rounded and fluffy white, pores purplish-pink and pruinose with spores; Berry (J.B.C., October, 1913, spores $7 \times 2{\cdot}5\mu$); National Park, (July, 1916); Taree District (H. Lyne, March, 1917); Victoria (September, 1913)—shed spores somewhat twisted, 7 to $8{\cdot}5 \times 3{\cdot}5\mu$; Mount Lofty, S.A. (J.B.C., July, 1914). In the National Herbarium, Sydney, there are specimens from the following localities:—Smoky Cape (F. W. Raffills, October, 1905); Chatswood (F.C. Lovegrove, August, 1903); Hornsby (A. A. Hamilton, October, 1909); Wahroonga (J. Staer, July, 1910); Lidcombe (A. Spencer, June, 1910); Grose Vale (Miss Campbell, Sept., 1912, duplicates of this determined by Lloyd); Gooseberry Island, near Dapto (E.C., April, 1912); Upper Lane Cove River (Miss P. Clarke, 1912); Gulgong; near Adelaide (J.B.C., 1898); Western Australia (J.B.C., February, 1908).

90a. TRAMETES LILACINO-GILVA var. STOWARDII Lloyd.

As *T. Stowardii*, Lloyd describes (Mycol. Notes, No. 48, 1917, p. 683) a form of *T. lilacino-gilva* with a strongly rugose pileus. Habitat Western Australia.

90b. TRAMETES LILACINO-GILVA var. EUCALYPTI Kalch.

Syn. *Polystictus eucalypti* Kalch, Grev. IV, 73; Cooke, No. 769.

Recorded by Cooke for Victoria and Queensland.

91. TRAMETES PLEBEIA Berk.

Syn. *Polyporus plebius* (Cooke, No. 664).

Recorded by Cooke for Queensland.

92. TRAMETES ROSEA Lloyd.

T. rosea Lloyd, Letter 59, 1914, Note 302.

Lloyd's description of the specimen sent to him by one of us (J.B.C.) —the locality from which it came has not been noted—is as follows:—'Context punky, dry, pale salmon (light ochraceous salmon). Pores white, medium large, $\frac{1}{2}$ mm. diameter, indistinctly stratified, forming imperfect layers in the manner of *Fomes annosus*. Spores 3×5 mic., hyaline, smooth.' He adds:—'The specimen received from you is evidently imperfectly developed. It is largely resupinate with imperfectly developed pilei. It agrees exactly with *Trametes roseola* as to context colour but differs from all other species in this section in having large pores. Its method of pore development is much like that of *Fomes annosus*. This is unnamed, similar to *Fomes annosus* in pore development only. Pores much larger, about five times. Context colour and texture different.'

93. TRAMETES CUPREO-ROSEA Berk.

'Pileus thin, rigid, attached by a reduced base ($6 \times 9 \times \frac{1}{2}$ cm.); surface striate fibrillose, pale rosy colour (pale buff). Context thin, hard. Pores medium to large, $\frac{1}{2}$ mm., round, at length long, sinuate, dædaloid, $\frac{1}{2} \times 2$ mm., rigid, with thin walls. Tissue concolorous.'—Lloyd.

Lloyd (Letter 63, 1916, p. 8) has identified specimens from Dr. Stoward of Western Australia.

Second General Division—DEPALLENS.

Section 63. Pores darker than the context, usually paling out in old specimens.

94. FOMES LIGNOSUS Klotzsch.

Syn. *Polyporus lignosus* Klotsch (Cooke, No. 662).

Recorded by Cooke for Victoria.

Third General Division—AURANTIACUS.

Section 64. Context orange rufous. Spores hyaline (or very pale coloured).

95. Fomes kermes Berk.

Syn. *Fomes pyrrhocreas* Cooke.

Lloyd has seen at Kew, under the above synonym, specimens from Australia.

Section 65. Context orange rufous. Spores coloured.

No Australian species recorded.

Fourth General Division—BICOLORIS.

Section 66. Pores dark brown. Flesh light buff.

No Australian species recorded.

Fifth General Division—FUNALIS.

Section 67. Pileus with a thick pad of dense, brown hairs, analogous to section Funalis in Polystictus.

No Australian species recorded.

Sixth General Division—FUSCUS.

Section 68. Context brown. Setæ, none. Spores hyaline.

A—Context light brown.

96. Fomes inflexibilis Berk.

Syn. *Polyporus recurvus* Berk.

Recorded by Cooke (No. 699) for Queensland.

97. Fomes exotephrus Berk.

Recorded by Cooke (No. 693) for Queensland.

B—Medium or Large Species.

98. Fomes fomentarius Linn.

'Pileus ungulate, with a hard, smooth, greyish crust. Context punky, dark brown (antique brown). Pores minute, with glaucous, pruinose mouths. Pore tissue paler than the context. Setæ, none. Spores hyaline, large, oblong, 5 × 16 mic.'—Lloyd.

Recorded by Cooke (No. 695) for New South Wales. We have never met with it.

99. FOMES CALIGINOSUS Berk.

Lloyd states that *Fomes endapalus* Berk (Cooke, No. 704), recorded for Queensland and New South Wales, has been identified as this species. The specimens from Australia that he has seen seem to him however to differ from young plants of *F. caliginosus*.

C—Small Species, 1 – 3 cm.

No Australian species recorded.

D—Plants dark purplish black. Context dark brown, with a purplish shade.

No species recorded for Australia.

Section 69. Context brown. Setæ present. Spores hyaline.

A—Context Light Brown.

100. FOMES POMACEUS Persoon.

"Pileus half unguliform, but usually more inclined to take a subresupinate form with the pileus imperfectly developed. Surface at first fulvous, tomentose on the margin, later cinerous; after wintering turns dark, but not black as in *Fomes igniarius*. Context fulvous brown (amber brown), intermediate between the colour of context of *Fomes igniarius* and *robustus*. Pores minute, round, annual layers 5 – 6 mm. Setæ usually abundant, with thickened bases, projecting 12 – 16 mm. Spores globose, hyaline, 5 – 6μ."—Lloyd.

Lloyd states this species attacks plum, cherry, and other cultivated trees. He has identified a specimen from Western Australia (Letter 63, November 1916, p. 8—Dr. F. W. Stoward).

101. FOMES ROBUSTUS Karsten.

"Pileus ungulate, with a hard, rimose, black crust. Context light fulvous. 'Rhei' colour would be the best name

for it, being the colour of commercial rhubarb root. Pores minute, with pore tissues concolorous. Spores globose, hyaline, 7 – 8μ, guttulate when fresh. No setæ found by me. (I am informed that setæ have been found in a Swedish specimen)'—Lloyd.

We have the following specimens:—A large sporophore, 7½ ins. wide, 5 ins. broad and 3 ins. deep (Milson Island, Hawkesbury River, on fallen Eucalyptus, 1912); two small sporophores, the largest 2 ins. broad, on *Leptospermum* sp. (Mount Irvine, June 1915, spores not seen and no setæ detected—the small size of the branches of this shrub probably accounts for the small size of the fruiting body); a small sporophore growing on the small trunk of *Leptospermum flavescens* (Wiseman's Ferry, August 1915, a few doubtful colourless spores seen, no setæ detected); medium sized sporophore on *Casuarina* sp. (Stockton, October 1915, spores spherical, 7μ, 7·5 × 7μ, some doubtful setæ seen); locality not noted (spores hyaline, 7·3 to 5μ, no setæ seen); large specimen, locality not noted; on dead *Kunzea corifolia* (Sydney, May, 1917); on dead Casuarina (Kendall, May, 1917); Narrabri, November, 1916; on *Angophora lanceolata* (Sydney, October, 1916, hyaline spores, 5·5 to 8μ); near Wauchope (February, 1917); Manly (November, 1916, spores 7 to 8μ); on living *Eucalyptus rostrata* (Moree, January, 1917); on *Angophora lanceolata*, (Hawkesbury River, November, 1916); at base of living *E. rostrata* (Adelaide Parklands, April, 1917, spores 5·5 to 7·2μ); on living *Robinia pseudacacia* (near Adelaide, April, 1917).

In identifying another specimen for us in which we had found pale brownish, almost hyaline, subspherical spores (8·5 × 7, 7 × 5·2μ) and no setæ, Lloyd adds:—'I did not find spores, but from context, colour, and your spore notes, "almost colourless," I judge it is this species. You have *F. robustus* typically in Australia, also a form with setæ.

I have always found the spores of *F. robustus*, however, hyaline.' As we have met with these faintly tinted spores in other specimens, possibly another species is involved.

The following are in the National Collection, Sydney:—New South Wales—Peakhurst (W. Buckingham, June, 1899); Penshurst, on Eucalyptus (E.C., July, 1907); Botany (L. Abrahams, November, 1908); Narrabeen (E.C., November, 1908); Gladesville (Miss M. Flockton, April, 1910) identified by C. G. Lloyd; Hornsby (A. A. Hamilton, October, 1909); Grose Vale (Miss Campbell, September, 1912) duplicates determined by Lloyd; Centennial Park, Sydney, (W. Forsyth June, 1909); Botanic Gardens on *Banksia ericifolia* (R. Bruce, June, 1910); Brewarrina (W.W. Froggatt, July, 1914) duplicates determined by Lloyd; Casino (D. J. McAuliffe, October, 1914); Kangaroo Flat, Walcha (W. Craigie, September, 1909); Narrandera on *Eucalyptus rostrata* (D. G. Stead, September, 1913). Lloyd (Letter 53, 1914) records a specimen from W. W. Froggatt, Australia, found on Needlewood *(Hakea sp.)*.

Tasmania—Hobart on *Eucalyptus viminalis* (E.C., March, 1910).

Western Australia—On tea-tree (Dr. Tidswell, June, 1909).

102. Fomes setulosus Petch.

'Pileus ungulate, with a smooth, brownish surface. Context fulvous (tawny of Ridgway), hard, woody, the pore tissue a shade lighter than the context. Pores very minute with brown mouths. Pore layers 2 – 3 mm. wide. Spores globose, hyaline, 8μ. Setæ very abundant, with thick bases and abruptly contracted and slender points, projecting 12 – 14μ.'—Lloyd. Lloyd adds that the context colour differs from that of *F. robustus* which on Ridgway's scale is yellow ochre; also that the setæ are very abundant, but in *F. robustus* rare or none. He says further, that in Aus-

tralia there seems to be an intermediate plant close to *F. robustus*. This probably refers to a specimen recorded by him (Letter 53, 1914) from J. Simmonds, Australia, as *F. robustus* var. *setulosus*. He has determined as *F. setulosus* specimens from Miss M. Flockton, probably from Port Jackson district.

103. FOMES CONCHATUS Persoon.

'Pileus usually thin, conchoid, with a sulcate, brown surface. Context light brown. Pores minute, concolorous. Setæ numerous, slender, with bases slightly thickened, projecting 20 – 28 mic. Spores hyaline, globose, $4\frac{1}{2}$ – 5 mic.' Lloyd.

Recorded by Cooke (No. 680) for Queensland and Victoria.

We have specimens, found growing on a Casuarina stump at Milson Island, Hawkesbury River, in March 1915, which Lloyd has identified as this species, adding 'agrees in all characters, though thicker than the usual European collections'; some specimens from this source have a blackish, rimose crust like that of *F. rimosus*. Another collection, evidently the same species, found growing through the bark of a Peppermint Gum *(Eucalyptus piperita)* in a more or less *Poria* fashion with illdeveloped pilei, at Neutral Bay, Sydney, in August, September and other months, Lloyd states is 'close to *Fomes conchatus* of Europe, that is, similar in context colour and microscopic details. The coloured setæ you will find in a section point to this species. *Polyporus gilvus* has the same setæ but the context colour is not the same'; spores hyaline, $4{\cdot}3$ to 5×2 to $2{\cdot}5\mu$. Other specimens are from Milson Island (September, spores $5{\cdot}5 \times 2{\cdot}5\mu$); Terrigal (June, 1914); Berry, on fallen trunk (October, spores $5 \times 3{\cdot}5\mu$); locality not noted (spores $4{\cdot}5$ to $5 \times 3{\cdot}2$ to $3{\cdot}5\mu$); on dead Casuarina (The Oaks, June, 1914).

103a. Fomes conchatus var. salicinus (F. salicinus Bull).

'Growing on willow, *Fomes conchatus* is usually subresupinate, or with a thick, imperfect pileate development. The context colour is also darker.'—Lloyd.

Recorded in Cooke (No. 691) for Queensland.

104. Fomes lineato-scaber Berk.

Fomes lineato-scaber Berk. and Broome, Linn. Trans., ii, 59, t. 11, f. 1; Cooke, Handb. of Aust. Fungi, No. 697.

'Pileus dimidiate, descending behind, rigid, brown (10 c.m. broad, 6 c.m. long); margin pallid, frequently zoned, lineate radiate, rough; hymenium rhubarb colour; pores punctiform, dissepiments obtuse (300μ diam.). On trunks, Queensland.' —Cooke.

In identifying a specimen sent to him, Lloyd says:—'To the eye, every feature, surface, context colour, pores, this is so much like *Trametes strigata* that I thought it must be a *Fomes* form of that species. The pores are stratified and it has setæ on the hymenium and belongs to Section 70 of the Fomes pamphlet. *Trametes strigata* has no setæ as far as I can find. When I observed the type of *Fomes lineato-scaber*, which is in the British Museum, I thought it a *Fomes* form of *Trametes strigata*, but I find on examination that it agrees with this specimen that you send in having setæ on the hymenium. It is a true *Fomes* with stratified pores, but was omitted from my Fomes Synopsis as I was under the impression that it was only a *Fomes* form of *Trametes strigata*.' This specimen was collected by one of us (J.B.C.) on Flinders Island, Bass Straits, in November 1912. We have specimens from Milson Island, Hawkesbury River, very like this but also indistinguishable from examples of *Polyporus gilvus*, with which we place them.

B—Context Dark Brown.

105. Fomes igniarius Linn.

'Pileus ungulate (often resupinate or subresupinate), with a hard, black, usually rimose crust. Context dark brown (argus brown), hard, woody. Pores minute, with concolorous tissue, and brown mouths. Pore layers 1 – 2 mic. (?mm) thick. Hyphæ deeply coloured. Subhymenial layer hyaline, cellular. Setæ rare, with swollen bases, projecting 12 – 16 mic. Spores globose, hyaline, 5 – 6 mic., smooth.'

Recorded by Cooke (No. 687) for all the States. We have not as yet encountered the species, and think it probable that the plants so determined were *F. robustus* or *F. rimosus*. Lloyd has examined a doubtful specimen from Australia.

106. Fomes Robinsoniæ Murrill.

Syn. *Fomes squarrosus* Wilson. Lloyd now considers *F. squarrosus* to be *F. Robinsoniæ*.

'Pileus ungulate, with a black, rough, rimose crust. Context hard, dark brown (antique brown). Pores minute, round, with concolorous mouths. Pore layers indistinct. Setæ few, slender. Spores hyaline, globose, 4 mic.'—Lloyd.

Recorded by Lloyd from Victoria.

A small specimen, about 3 ins. broad, obtained at The Oaks in June, 1914, is referred to this species, probably, by Lloyd, who says its microscopic characters are the same, but the context and texture appear a little different. In our specimen, the spores were oval, colourless, 4·5 to 5·2 or 7 × 3·4 to 4·2μ; setæ thick walled, acuminate, brown, 34 × 7μ, 27 × 8·5μ.

We have the following in addition:—On *Angophora lanceolata*, Sydney; at base of Eucalyptus, near Eulah Creek, Narrabri, November, 1916.

Section 71. Context brown. Setæ none. Spores coloured.

A—Context Light Brown.

107. Fomes rimosus Berk.

'Pileus unguliform, with a black, rimose surface, usually very rough, no distinct crust. Context bright yellow-brown (raw sienna). Pores minute, hard, annual layers 3 to 4 mm. thick. Pore mouths concolorous, when young velutinate to touch. Hyphæ deep bright yellow. Setæ none. Spores globose, deeply coloured, 5 mic.'—Lloyd.

Recorded by Cooke (No. 688) on gum tree trunks for New South Wales, Western Australia and Tasmania. Lloyd records a specimen from Dr. E. C. Stirling, Adelaide, departing from the type in being narrow, ungulate and with pores slightly larger.

We have the following specimens:—Jerilderie (Dr. Ferguson, October, 1913), spores yellow-brown, spherical or somewhat triangular or oval, 5·2 to 6μ—identified by C. G. Lloyd—another sporophore collected at the same time was 4 ins. in width ; on *Casuarina* sp., Milson Island, Hawkesbury River, $3\frac{1}{2}$ ins. wide, $2\frac{1}{4}$ ins. deep, $1\frac{1}{4}$ ins. high (October 1915, spores oval to triangular, yellow-brown, 7 to $8 \times 3{\cdot}5\mu$); Milson Island (J.B.C., August), spores yellow-brown, 5·2 to $6 \times 3{\cdot}4\mu$; on *Casuarina* sp., Baan Baa near Boggabri, January, 1917; on *Casuarina Luehmanni*, Pilliga Scrub, Narrabri, November, 1916; on *Angophora lanceolata*, Hawkesbury River, November 1916, a huge sporophore, $7\frac{1}{2}$ ins. high $\times$ 6 ins. $\times$ 5 ins. (spores brown, subspherical to triangular, 6·5 to 7·5 $\times$ 5 to 5·5μ); on *Eucalyptus crebra* or *E. melanophloia*, Narrabri, November, 1916 (approaching the var. *badius* in the pores being larger, spores yellow-brown, 6·8 to 7·5 $\times$ 5μ, identified by Lloyd).

107a. Fomes rimosus var. Niaouli (F. Niaouli Patouillard).

'Pileus unguliform, or thick, applanate, with dark brown or black, matted, tomentose surface. Context colour dark

brown (Argus). Pores minute, with concolorous tissue and darker brown velutinate mouths. Setæ none. Spores globose, 6 mic., deeply coloured.'—Lloyd.

In identifying a specimen for us, Lloyd says:—'*Fomes Niaouli* Pat. I doubt if really distinct from *F. rimosus.* The spores in this specimen were brown, oval, 7 × 5μ. No setæ were seen.

108. FOMES SCABER Berk.

Recorded for Tasmania (Berkeley) and Australia (Lloyd).

B—Context Dark Brown.

109. FOMES PECTINATUS Klotzsch.

Recorded by Cooke (No. 701) for Queensland.

110. FOMES PULLUS Montague.

Recorded by Cooke (No. 696) for Queensland.

111. FOMES TEPPERI Lloyd.

'Pileus ungulate, with black, rimose surface. Context dark brown (russet). Pores large, long, seemingly not stratified. Setæ, none. Subhymenial cells forming a thick layer. Spores are many, subhyaline, 6 to 7μ, globose; a few are deeply coloured, of the same size and shape.'–Lloyd.

The name of this species suggests that the type came from South Australia, where Mr. Tepper has collected for C. G. Lloyd. We have specimens, identified by Lloyd, collected at Baan Baa near Boggabri in New South Wales, in January, 1917, on a dead rough-barked tree Acacia (*A. Cheelii*, confused with *A. glaucescens*). There were numerous pale yellowish-brown oval to irregularly polygonal spores, 8·5 × 6μ, 7·8 × 6μ, etc.

Section 72. Context brown (orange-brown in one species). Setæ present. Spores coloured.

A—Context Light Brown.

112. FOMES YUCATENSIS Murrill.

'This is similar in every particular to *Fomes rimosus*, excepting that it has setæ.'—Lloyd. Lloyd has identified

for us as this species, a *Fomes* growing about twelve feet up the trunk of a fine specimen of *Eucalyptus saligna* at Lisarow in August, 1916. Spores distinctly brown-tinted, 6 to 7μ; dark brown, pointed setæ, 17 × 7μ. This is evidently a timber-destroying species of economic importance.

B—Context Dark Brown.

113. FOMES LINTEUS Berk.

Recorded by Cooke (No. 700) for Queensland. As Lloyd says that he believes this species is only known from the type at Kew from Nicaragua, this record seems very doubtful.

Seventh General Division—GANODERMUS.

Section 73. Fomes—Ganodermus.

A—Pores with Thin Walls. Spores Smooth or Punctate.

114. FOMES APPLANATUS Persoon.

Syn. *Ganoderma applanatum* Pat. in Bull. Soc. Myc. Fr. 1889, p. 67; Wakefield, Kew Bull. (1915), 364.

'Pileus usually applanate, with a brown, rather soft crust when fresh. Context colour dark brown (bay brown). Pores minute, with brown tissue and white mouths. Spores coloured, obovate, 6 × 10 mic., truncate at the base, with smooth, punctate surface.'—Lloyd.

We have the following specimens:—Helensburgh, W. Craigie, August, 1909, determined by Lloyd, and J.B.C., (Oct. 1914, spores thick-walled, oval, finely warted, brown, 9·2 to 10 × 6 to 7μ); Lisarow (J.B.C., April, 1915, and June, 1916); Thirroul (J.B.C., April); National Park, July, 1916; Wingham, November, 1916; Mount Wilson, May, 1915; Flinders Island, Bass Straits (J.B.C., November, 1912). We have also a series of small ungulate poorly developed sporophores taken in October and November 1914, December 1915, and June 1916, from the base of a specimen of *Angophora lanceolata* at Mosman, Sydney, which have very

short pores and very thick context—the young plants are covered with a beautiful greyish-brown bloom—the spores are thick-walled, brown, smooth, 8·5 to 11 × 5·5 to 7μ; Lilyvale and Mount Keira (A. A. Hamilton, June, 1910); Upper Fern-tree Gully, Victoria (E.C., February, 1908); Russell Falls, Tasmania (E.C., March, 1910); Adelaide, S.A. (J.B.C., 1898); Mount Chincogan (T. McDonough, May, 1910).

114a. FOMES APPLANATUS var. LEUCOPHÆUS (F. LEUCOPHÆUS Montague.)

A form of *F. applanatus* with a hard pale or white crust (Lloyd). Lloyd has identified for us as this form, a specimen obtained ten feet up the trunk of a tree at Mount Irvine in June, 1915.

114b. FOMES APPLANATUS var. AUSTRALIS (F. AUSTRALIS Fries).

F. applanatus Cheel, Proc. Linn. Soc. N.S.W., xxv, (1900) 672.

A tropical form with thin context and long pores (Lloyd).

A specimen of this variety identified as *F. australis* by Lloyd, is in the National Herbarium, Sydney; the pileus is over 14 × 9 ins., and grew in the fork of the branches, about four and a half feet from the ground, of an exotic Acacia *(A. horrida)*, which eventually died through its attack. We have also the following specimens:—Mount Wilson (J.B.C., June, 1915), and on *Ligustrum lucidum*, Paddington (E. Bennett, February, 1912).

114c. FOMES APPLANATUS var. OROFLAVUS (F. OROFLAVUS Wilson).

A tropical form with yellow pore mouths (Lloyd).

One of us (E.C.) collected a specimen of this plant at Upper Fern-tree Gully, Victoria, in February, 1908, and there are also specimens in the National Herbarium, Sydney, from Nauru Island (Ocean Island Group) collected by T. W. Steel in June, 1908.

114d. FOMES APPLANATUS var. NIGRO-LACCATUS (F. NIGRO-LACCATUS Cooke).

Tropical forms with a slight, black, resinous exudation on the crust (Lloyd).

B—Spores Rough.

No Australian species recorded.

Section 74. Ponderosus-Fomes-Ganodermus. Pores hard, heavy, minute, with thick walls. Spores smooth or punctate.

No Australian species recorded.

Section 75. Stipitate Fomes of the Section Ganodermus.

No Australian species recorded.

III. POLYPORUS (SECTION APUS).

(Comprising Sessile Species of the Genus Polyporus.)

I. Context and pores white or pale when growing, spores hyaline.

Pileus with thin but distinct crust	Section	76
Pileus without distinct crust—		
Flesh (dry) fragile, crumbly	„	77
Flesh hard, firm	„	78
Very thin plants	„	79
White, turning reddish in drying ...	„	80
White, turning bluish in drying ...	„	81
Flesh dry, soft and cottony	„	82
Flesh dry, light and spongy	„	83

II. Context white or pale, pores coloured, spores hyaline.

Thin plants, pileus less than a cm. thick ...	„	84
Thick plants, ungulate	„	85
Thin plants, with gelatinous pores	„	86

III. Context and pores coloured, spore hyaline.

Context isabelline or yellow	„	87
Context orange-red, soft, spongy	„	88

Context vinaceous or purple...	Section	89
Context olive...	,,	90
Context brown. Setæ none...	,,	91
Context brown. Setæ present	,,	92

IV. Context and spores coloured. Spores not truncate.

Context pale (white ?) or isabelline. Setæ none	,,	93
Context yellow. Setæ none...	,,	94
Context brown. Setæ none...	,,	95
Context brown. Setæ present	,,	96
Context brown, light, spongy, fibrillose. Setæ none	,,	97

V. Polyporus—Ganodermus. Context brown. Spores coloured, truncate.

Context soft, spongy...	,,	98
Context firm, not spongy	,,	99
Polyporus—Amaurodermus	,,	100

First General Division—Context and pores white or pale when growing, spores hyaline.

Section 76. Pileus with thin but distinct crust.

A—Flesh firm and fragile.

115. Polyporus betulinus Bull.

Recorded by Cooke (No. 654) for Queensland on beech.

116. Polyporus albellus Peck.

Syn. *Polyporus chioneus* Cooke, Handb. of Aust. Fungi, No. 635.

'Pileus dimidiate, sessile, usually $1\frac{1}{2}$ to 2 ins. in diameter, often imbricate, but rarely, if ever, subresupinate. Surface smooth, with a very thin crust. Colour of surface usually grayish or yellowish, sometimes white. Flesh drying white, fragile. Pores small, round, drying slightly alutaceous. Spores allantoid, 1×4 to 5 mic., cylindrical, curved.'–Lloyd.

Recorded by Cooke under the above synonym for Victoria, New South Wales, and Queensland.

117. Polyporus portentosus Berk.

Syn. *Polyporus portentosus* Berk., Hook. Journ. 1845; Cooke, Hand. of Aust. Fungi, No. 655.

'Pileus usually large, 3 – 4 inches in diameter, 2 – 3 inches thick. Surface with a distinct, thin, pale yellowish crust. Flesh pure white, fragile, chalky. Pores minute, pure white.'—Lloyd.

Recorded in Cooke for all the States except Queensland. Some at least of the Victorian records refer to *P. australiensis* (which see).

We have a specimen of a decayed large white polypore from Hill Top, found under a fallen log, which may be this species. Of portion of a very large polypore collected by one of us (J.B.C.) on Flinders Island, Bass Straits, in November, 1912, Lloyd says:—"I believe this specimen is *P. portentosus*, though it is somewhat doubtful. I have a plant from Geo. K. Hinsby, which agrees exactly with the type at Kew. The tissue of the pores is white the same as the context. In your specimen the pores are discoloured. The cuticle of the type is thin but distinct. The surface of your specimen is similar as to colour but does not have a distinct cuticle. Spores allantoid, $1{\cdot}5 \times 7\mu$ in your specimen." The pores in our specimen are $\frac{1}{4}$ in. deep. Our measurements of the spores were $5 \times 1{\cdot}7\mu$, elongated.

118. Polyporus tephronotus Berk.

Polyphorus tephronotus Berk., Fl. Tasm., II, 252, t. 182, f. 5; Cooke, Handb. of Aust. Fungi, No. 626, fig. 54.

Syn. *Polyporus angustus* Berk., Fl. Tasm. II, 253, t. 182, f. 6—resupinate form (Lloyd); Cooke, Handb. of Aust. Fungi, No. 632.

'Pileus dimidiate, thin 5 – 6 mm. Surface smooth, with a thin but distinct crust, slightly yellowish. Flesh white,

soft, brittle. Pores very minute, discoloured slightly, with a waxy appearance. Spores not found (allantoid ?).'–Lloyd.

Recorded in Cooke for Tasmania. We have not met with the species.

119. POLYPORUS PELLICULOSUS Berk.

Cooke, Handb. of Aust. Fungi, No. 650.

Syn. *Polyporus spiculifer*, Cooke, (No. 651). A "thin form with the tomentum collected into very distinct nodules."—(Lloyd).

Recorded for Queensland, Victoria and Tasmania.

B—Flesh soft, spongy.

120. POLYPORUS EUCALYPTORUM Fries.

Polyporus eucalyptorum Fries in Lehmann's Plantæ Preiss., II, p. 135 (1846-47); Fries, Epicr., 462; Cooke, Handb. of Aust. Fungi, No. 656; Baker, Proc. Linn. Soc. N.S.W., XXIV (1899), 447; Cheel, ditto, XXXII, (1907), 203.

Syn. *Polyporus hololeucus* Kalchbrenner, Hedw. XV, 114 (Lloyd); *Polyporus leucocreas* Cooke (Loyd). *Xylostroma gigantea* Cheel, Proc. Linn. Soc. N.S.W., XXXV (1910), 308 and 309, and Ann. Rep. Bot. Gdns., 1910 (1911), 11.

'Pileus ungulate (or thick, applanate), 3 to 5 inches in diameter. Crust very soft, pale, at length dark, easily separating. Context very soft, white, spongy, crumbly, fragile. Pores medium, round, white, fragile, 6 to 12 mm. long. Spores abundant, 8 to 10 mic., many smaller, subglobose, with granular or guttulate contents.'—Lloyd.

Cooke records the species from Victoria and Western Australia. Cheel and Baker *loc. cit.*, have both recorded it, the former for the Botanic Gardens, Sydney, and Hill Top, the latter for Gerogery on Stringybark (*Eucalyptus capitellata*). McAlpine (System. Arrang. of Aust. Fungi, 1895) adds South Australia to Cooke's localities.

We have examined a fine series of specimens in the National Herbarium, Sydney and in our private collections from the following localities, which are referable to this species:—Pittwater, (A. Maclellan, September, 1907); Nepean River, between Mulgoa and Norton's Basin (W. Craigie, October, 1908); Botany, (L. Abrahams, November, 1909); Wamberal, (E. Cheel, April, 1911); Government Domain on *Eucalyptus pilularis* and *E. resinifera* (W. Briggs, March, 1912 and E. Cheel, June, 1915); Botanic Gardens, on *E. tereticornis* (E. Cheel, April, 1916); Milson Island, Hawkesbury River (J.B.C., June, 1912) on *E. corymbosa;* Tenterfield (J.B.C., August, 1917) on *E. cinerea* F.v.M. var. *nova-anglica*, Maiden. We have also seen specimens on Eucalypts in the Mount Lofty Range, South Australia (pore mouths bright yellow). The spores of our specimens measured $10 \times 8{\cdot}5\mu$ in one, and 8 to 9×6 to 7μ, elliptical and very pale yellow in the shed mass in another.

The flat sheets of sterile mycelium found in felled tree trunks have been referred to as *Xylostroma gigantea* by one of us (E.C., *loc. cit.*). The following specimens of this nature are in the National Collection, Sydney:—From Stringybark *(Eucalyptus eugenioides)*, Walcha; from *E. Caleyi*, Inverell District; from 'Red Gum,' Wilgo and Cobargo; from 'White Gum,' Cross Roads near Sutton Forest; from Parkes.

Section 77. Context and pores white or pale, flesh fragile, crumbly.

121. Polyporus immaculatus Berk.

Syn. *P. verecundus* Berk. and Curt., Cooke, Handb. of Aust. Fungi, No. 629 (Lloyd).

Cooke records this species from Fiji. Lloyd states it occurs in Australia (p. 303).

122. Polyporus cretaceus Berk.

Recorded by Lloyd for Tasmania.

Section 78. Context and pores white or pale. Flesh drying hard, firm.

A—Surface anodern, or pubescent with projecting hyphæ.

123. Polyporus fumosus Pers.

Syns. *Polyporus rhinocephalus* Berk., Fl. Tasm. II, 253, t. 182, and Cooke, Handb. of Aust. Fungi, No. 645 (type appears to be *P. fumosus*—Lloyd); *P. demissus* Berk., Hook. Journ. 1845, 52, and Cooke, Handb. of Aust. Fungi, No. 644 (type appears to be *P. fumosus*—Lloyd).

'Pileus thin, smooth, with dull, soft surface. Context, when dry, hard, firm, but brittle; white when fresh, darker when dried. Pores small, round, irregular, white at first, but becoming fuliginous, or dark, in drying. Spores $2\frac{1}{2} \times 5$ mic. *Polyporus fumosus* is quite a frequent plant, usually on willow. It is the same, in fact as *Polyporus salignus*, with small pores. When it is in its prime, and growing, it is white; but on drying it turns more or less smoke coloured. It is often confused with *Polyporus adustus*, and many specimens in the museums are labelled as being *Polyporus fumosus*. Dried specimens may be confused sometimes, but the difference is marked in the fresh plant. *Polyporus adustus* has deep, smoke coloured pores when growing; *Polyporus fumosus* has white pores, turning smoky in drying, but when dry rarely deep enough in colour to be confused with *Polyporus adustus*. With *Polyporus salignus*, however the case is different. It is the same plant as *Polyporus fumosus* with larger pores. When growing white, it is usually called *Polyporus salignus*. In drying or after it turns 'smoky' it becomes *Polyporus fumosus*. When fresh, *Polyporus fumosus* has a pleasant odour, as noted by Persoon.'—Lloyd.

Under the two synonyms given above, Cooke records this species respectively for Tasmania and Western Australia. Specimens collected by one of us (J.B.C.) at Kurrajong

Heights (August, 1912), Lloyd states seem to be exactly the same as the American plants. The spores of these were 4·3 to 5 × 3μ. We have also specimens from Tuggerah (October, 1914). Another collection obtained on an old Casuarina stump at Milson Island, Hawkesbury River, in September, 1914, Lloyd also thinks is this species though it is doubtful, as the pores do not turn 'smoky'—the spores are 5·5 to 7 × 2·5 to 3·5μ.

124. Polyporus epileucus Fries.

This has been recorded by Cooke (No. 627) for Queensland, but from Lloyd's description of the species, we doubt the identification.

B—Surface strigose with brown hairs.

No Australian plants recorded.

C—Spores large, hyaline, truncate, corresponding to *Ganodermus* spores.

125. Polyporus ochroleucus Berk.

Polyporus ochroleucus Berk., Hook. Journ. 1845, 53.

Syn. *Trametes ochroleucus* Cooke, Handb. of Aust. Fungi, No. 847; Wakefield, Kew Bull. 1915, 366; *Fomes compressus* Berk., Hook. Journ. 1845, and Cooke, Handb. of Aust. Fungi, No. 709 (Lloyd).

'Pileus usually well formed, regular, ungulate (3 to 4 × 1½ to 2 cm.). Surface with indistinct crust, smooth, or more or less appressed, strigose, fibrillose, faint indications of zones. Colour usually pale with a slight ochraceous tint, rarely decidedly yellowish. Context thin, hard; at first pale, in old specimens becoming dark. Pores small, ¼ mm., regular, long, minute, rigid. Spores pecular, oblong, truncate at base, 8 × 16 mic., hyaline.'—Lloyd.

This species is very common, especially on fences and fallen timber in Australia, and is doubtless, in many instances, an active agent in their early rotting. We have

met with a telephone post being destroyed by its attack. Systematic destruction of the fruiting bodies will probably tend to diminish the incidence of attack. It is recorded by Cooke for all the States except South Australia. Lloyd, has received specimens from Mr. Tepper, probably from Adelaide, and we have Adelaide examples in our collection. Spores in our specimens 12 to 17 × 5·2 to 8·8μ. We have specimens from Sydney (August and June), National Park (July, August), Hawkesbury River (November), Berry (October), Orange (October), The Oaks (June), Murwillumbah (April), Narrabri (May and November), Mummulgum near Casino (December), near Wauchope (February) —in New South Wales, and from Adelaide.

The following specimens are in the National Collection, Sydney:—Bowral and Penshurst (E.C., 1907); Hillgrove (Lewis, 1910); Scone (J.L.B., 1907); Muswellbrook (W. F. Blakely, 1911); Botanic Gardens, Sydney (E. Bernard, March, 1912, and J. Nichol, August, 1910); Hill Top (E.C., January 1911 and April 1914); La Perouse (A. A. Hamilton, April, 1910); Thornleigh (J. Staer, August 1910); on *Eucalyptus* sp., Lilyvale (A. A. Hamilton, April 1912); Jellore Creek (E.C., April, 1912); Gladesville (Miss Flockton, April 1910); Leura (A.A.H., April 1908); Hornsby (A.A.H., Oct. 1909); Upper Fern-tree Gully, Victoria (E.C., February 1908); Willoughby (A. G. Hamilton); Bowral (R. Nichol, March, 1898); Rookwood (A. G. Hamilton, June 1910).

D—Pileus a hollow globe, bearing the pores on upper side of the interior. No Australian species recorded.

E—Trametes.

128. Trametes Cubensis Mont.

Recorded by Cooke as *Polyporus Cubensis*, (No. 663), for Queensland.

Section 79. Very thin white plants.

No Australian species recorded.

Section 80. White when fresh, but turning reddish in drying or with reddish spots on the surface.

127. POLYPORUS FRAGILIS Fries.

Recorded by Cooke (No. 633) for Victoria.

Section 81. White when fresh, turning blue when touched.

128. POLYPORUS CÆSIUS Schrader.

Polyporus cœsius Fries, Syst. Myc. I, p. 360; Massee, Brit. Fung. Flora, I, p. 252.

'Pileus sessile, white, turning blue at once when touched, and drying greyish. Flesh soft, white, turning blue when broken. Pores large, sinuate, with uneven edges. Spores $1\frac{1}{2} \times 5\mu$, rod-shape, straight, hyaline, smooth. This is a frequent plant, usually on pine. It occurs more rarely on frondose wood, and we have collected it on willow. It is common in Europe and America, and recorded in Africa. There should be no trouble in telling *Polyporus cœsius*, for it is the only species that turns blue when touched. The dried specimens have a greyish-white cast by which they may be recognised.'—Lloyd.

Plants collected by one of us (J.B.C.) at Mount Wilson in June, are stated by Lloyd to be exactly the same as dried specimens of this species. No note was made at the time as to whether the flesh turned blue on being bruised, though we believe it did. Further specimens, also identified by Lloyd, obtained on logs on the Blue Mountains on the following June were quite white when gathered. On section, the flesh occasionally or in spots turned greyish-green. The tubes slowly turned a bluish-grey-green. The flesh cut soft like a cheese. There was no smell. The spores are not straight, but *slightly curved*, 4·2 to 5 × 1 to 1·5 μ; the spores of typical *P. cœsius* Lloyd gives as straight.

Section 82. Context very soft and cottony.

No Australian species recorded.

Section 83. Context when dry, spongy and light.

A—Pores large, sinuate.

129. Polyporus borealis Fries.

Cooke records this species (No. 652) for Victoria.

B—Pores small, round.

130. Polyporus pelles Jarvis.

Lloyd records this for Queensland.

Second General Division.—Context white or pale, pores coloured, spores hyaline.

Section 84. Thin plants, less than a cm. thick.

131. Polyporus adustus Willd.

Polyporus adustus Massee, Brit. Fung. Flora V, 2, 1, p. 249 ; Cooke, Handb. of Aust. Fungi, No. 646.

Syn. *Polyporus strumosus* ? Cooke, Handb. of Aust. Fungi (No. 657)—Lloyd.

From Lloyd's remarks we gather that *P. strumosus*, recorded by Cooke for Victoria, is probably *P. adustus*. Cooke records *P. adustus*, as such, for Victoria and Queensland.

132. Polyporus campylus Berk.

Recorded by Cooke (No. 637) for Tasmania.

Section 85. Thick, ungulate plants.

133. Polyporus australiensis Wakefield.

Polyporus australiensis Wakefield, Kew Bull. (1914), 157.

The original description of this species is in Latin which may be briefly translated as follows:—'Pileus flesh-coloured, sessile, thickened at the base, 5 to 10 cm. or more in diameter, 1 to 2 cm. thick in the medial part gradually increasing up to 3 cm. at the base; cuticle smooth, bright orange or more or less of an orange colour tinged red; context in dried specimens tough and contracted, somewhat

pallid. Pores flesh-coloured, contracted in dry specimens, the mouths about 1 mm. diameter, 2 to 9 mm. long. Spores not seen.'

The localities given are as follows:—Coomera River and Toowoomba in Queensland, and Grampians in Victoria. Specimens from the latter are in Kew Herbarium labelled *P. portentosus* Berk.; Geographe Bay (in Herb. Kew as *P. stypticus* Fr.); also a specimen from Victoria (without specific locality) labelled *P. retiporus* Cook.

The author further states that it is 'a very distinct species near to *P. sulphureus*, and said to have a very strong odour when fresh. It differs from *P. portentosus*, *retiporus*, and *stypticus*, with which it was confused in the early records quoted above, in the brilliant orange-yellow tints in pileus and pores, and in the yellowish flesh. (Ridgway, tab. III, 15b).'

We have specimens of this species collected by one of us (E.C.) on a dead Eucalyptus stump, on the Nattai River near Colo, viâ Hill Top, March, 1914. These specimens were somewhat hoof-shaped, 8 × 12 cm. and 9 cm. thick, the pores orange red coloured when fresh, the upper part or surface of pileus being of a rich cream colour tinged with ochre and orange red. Spores globose, smooth, transparent, about 3μ diam. In the National Herbarium collection there is also a fine specimen collected at Albany, Western Australia, by Mr. J. Staer (February 1911). When fresh, the specimens had a very strong not unpleasant odour, which is retained in the dried specimens in the herbarium for a long period. The National Collection has also specimens from Nowra (A.H.S. Lucas and A. A. Hamilton, 1916). One of us has a specimen from Malanganee, 25 miles west of Casino, on a stump, August, 1917. We have also received from Mr. Brittlebank portion of a large growth found on a post at Drouin, Gippsland, which from the context and the

odour appears to belong to an immature plant of this species. Lloyd (Letter No. 63, 1916) has identified Western Australian specimens forwarded by Dr. Stoward.

Section 85. Thin plants, somewhat gelatinous when fresh.

134. Polyporus dichrous Fries.

'Pileus thin, dimidiate, usually imbricate. Surface smooth, white, no crust. Flesh white, thin, firm. Pores small, dark purplish-brown, gelatinous. Spores allantoid, 4 to 5 × 1·5μ, hyaline, curved.'—Lloyd.

Recorded by Cooke (No. 647) for Victoria. We have specimens identified by Lloyd obtained on a fallen pine log (*Callitris*) near Forbes in August, 1915.

Third General Division—Context and pores coloured, spores hyaline.

Section 86. Context isabelline or yellow.

135. Polyporus rutilans Pers.

Recorded as *P. nidulans* (No. 638) by Cooke for Queensland —a synonym, (Lloyd).

136. Polyporus zonalis Berk.

Polporus zonalis Berk., Ann. Nat. Hist. x, 375; Cooke, Handb. Aust. Fungi, No. 660.

'Pileus thin (4 – 6 mm.), rigid, drying hard, incurved. Surface reddish-brown, with narrow, concentric, raised zones. Context thin, hard, pale ochraceous. Pores minute, 3 – 4 mm. long; when old, brown, but my impression is that they are orange when fresh. Spores abundant, globose, 4 – 5 mic., hyaline, smooth.'

This is a common species throughout the tropical world —Lloyd.

Recorded by Cooke for Victoria and Queensland. Lloyd's Australian specimens from W. W. Froggatt indicate its occurrence also in New South Wales.

136a. POLYPORUS ZONALIS var. RIGIDUS Lev.

Polyporus rigidus in Lloyd's Syn. of Genus Polyp. p. 337.

'This is close to *Polyporus zonalis*, the same general nature and surface. It differs from *zonalis* in having pale pores, with only slightly ochraceous tissue when recent, and never dark as they are in *Polyporus zonalis*. Spores 4 to 6μ, are a shade larger, and the surface is not so strongly zoned.'—Lloyd.

Specimens, collected at Katoomba in June, 1916, have been identified by Lloyd. A few doubtful spores, sub-spherical and 3μ in diameter, seen.

137. POLYPORUS SEMILACCATUS Berk.

'Pileus sessile, applanate, thin (4 – 8 mm.), rigid. Surface smooth, brown, variegated with darker, imperfect zones or blotches. Context firm but punky, dark isabelline (clay colour). Pores minute ($1-1\frac{1}{2}$ mm. long), darker than the context, rigid. Spores not found.'—Lloyd.

Recorded by Cooke (No. 718) for Queensland as *Fomes cinereo-fuscus* Curry, which species Lloyd states is dis-coloured *P. semilaccatus.*

Lloyd has identified specimens for us collected at Eumundi, Queensland, by J. Staer.

138. POLYPORUS ANEBUS Berk.

Polyporus anebus Berk., Hook. J., 1847, 504; Cooke, Handb. of Aust. Fungi, No. 666.

'Pileus thin, 5·8 mm., rigid, sessile, imbricate. Surface hard, smooth, brownish-yellow, no distinct crust. Flesh pale yellow (cinnamon-buff), firm, dry, fissile. Pores minute, 2 – 3 mm. long, slightly darker than the flesh. Hyphæ pale yellow. Setæ none. Spores subglobose, 3 to 4 mic., hyaline, smooth.'

Recorded by Cooke from Queensland.

We have specimens from Mount Wilson, collected in June 1915 which have been identified by Lloyd.

138a. Polyporus anebus var. bicolor (*P. bicolor* Jungh.)

Syn. *Fomes oblinitus* Berk., Cooke, Handb. of Aust. Fungi, No. 715 (Lloyd).

Lloyd states that this is the same as *P. anebus*, except that the pileus develops a reddish stain and sometimes the surface is entirely dark reddish. Under the above synonym Cooke records it for New South Wales.

Section 87. Context orange, red, soft, spongy.

No Australian species recorded.

Section 88. Context vinaceous or purple.

139. Polyporus durus Jungh.

Lloyd mentions that he has seen Australian specimens. Recorded by Cooke as *Polyporus cartilagineus* (No. 659), *P. testudo* (No. 665), and *Fomes ponderosus*, probably, (No. 707), all for Queensland.

140. Polyporus vinosus Berk.

'Pileus thin, usually sessile, dimidiate, dark vinaceous colour (dark livid purple). Surface smooth, concolorous. Context thin, brittle, hard, more brown than the surface. Pores minute, dark, concolorous with the surface. Spores allantoid, $1\frac{1}{2} \times 4$ to $4\frac{1}{2}\mu$, hyaline.'—Lloyd.

Lloyd has identified specimens for us collected at Port Moresby, New Guinea, by A. E. Pratt.

Section 89. Context olive.

141. Polyporus supinus Swartz.

'Pileus dimidiate, imbricate, often resupinate behind usually with a thin margin. Surface, when fresh, white, dull; when young, minutely pubescent, soft to the touch; when old often spotted with red spots behind. Context dark olive (Dresden brown), hard, firm. Pores minute, 2–4 mm. long, with isabelline tissue and adustus mouths. Spores 4×8 mic., oblong, hyaline, smooth with granular contents."—Lloyd.

This species has not been recorded for Australia, but is inserted on account of the following species.

142. POLYPORUS SUBOLIVACEUS Berk.

'This has the same context colour and is quite close to *Polyporus supinus*, and the old herbarium specimens can hardly be told apart. Fresh specimens, however, appear quite different. *Polyporus subolivaceus* is unicolorous, with a uniform pileus, surface and context colour, while in *Polyporus supinus* there is a strong contrast between the context and surface colour.'—Lloyd.

One of us, J.B.C., collected plants at Thirroul, in April, 1909, which Lloyd has identified as this species, 'a rare plant heretofore only known to me from Brazil.'

Section 90. Context brown. Setæ none.

No Australian species recorded.

Section 91. Context brown. Setæ present.

143. POLYPORUS GILVUS Schwein.

Polyporus gilvus, Cooke, Handb. of Aust. Fungi, No. 641.

Syn. *Fomes homalopilus (P. carneofulvus)* Cooke, *loc. cit.*, No. 716; *Fomes rubiginosus (P. Lawrencii)* Cooke, *loc. cit.*, No. 702.

'Pileus sessile, applanate, thin $\frac{1}{2}-1\frac{1}{2}$ cm., often imbricate. Surface brown, even, usually slightly rugulose. Context hard, firm, of the growing plant often bright gilvous (yellow ochre) varying to brown (cinnamon brown) when old. Ordinarily the context is more brown than yellow. Pores are small, round, $3-10$ mm. long, with brown tissue and mouths. Setæ abundant, slender, sharp, projecting $12-16$ mic. Spores hyaline $3\frac{1}{2} \times 4-5$ mic., smooth.'—Lloyd.

Recorded by Cooke for Queensland and Western Australia.

We have the following specimens:—Tuggerah (J.B.C., October, 1914), identified by Lloyd who adds:—'The flesh

of your plant is more ligneous than, not so brittle as, that of our common American plant, but surely the same species' —our specimens have acuminate, dark brown cystidia, 26 $\times$ 5μ and spores apparently yellow-brown and somewhat irregular, 3·5 to 5 $\times$ 2 to 2·5μ; Milson Island, Hawkesbury River (J.B.C., November, 1914), cystidia present; Neutral Bay; Dungog (J.B.C., November, 1916).

Specimens from the following localities are in the National Herbarium, Sydney:—Smoky Cape near Trial Bay (F. W. Raffills, 1905); Guy Fawkes (J. Staer, November, 1909); Tuggerah Lakes (April, 1915); Hornsby and Chatswood (A. A. Hamilton, August, 1913 and October, 1911); Rookwood (A. Spencer, June, 1910); Penshurst (E.C., July, 1907); Thornleigh (J. Staer, August, 1910); Parramatta (E.C., March, 1908); Neutral Bay (J.B.C., 1912); Middle Harbour (A. A. Hamilton, October, 1909); Milson Island, Hawkesbury River (E.C., July, 1912); Thirroul (E.C., April, 1910); Hill Top (E.C., April, 1914); Grose Vale (Miss Campbell, Sep., 1912); Leura (A. A. Hamilton, Feb. 1911).

143a. POLYPORUS GILVUS var. SCRUPOSUS Fries.

Polyporus scruposus, Cooke, Handb. of Aust. Fungi, No. 642; *P. isidioides* (*P. stenoloma*), Cooke, Handb. of Aust. Fungi, No. 643.

'Perfectly smooth forms of *Polyporus gilvus* rarely occur, but the form called *Polyporus scruposus* is excessively rough, with little tubercles and granules. It was named from the United States, but these rough forms are more common and strongly marked in Africa than in the States. As it grades into the type form in all degrees, it is difficult to maintain even as a form.'—Lloyd.

Recorded by Cooke for all the States except South Australia. Lloyd (Letter 63, 1916) also records it for Western Australia.

We have specimens of *P. gilvus* probably referable to this form, from Sydney, on sawn log of firewood (J.B.C., Oct., 1914); Narrabeen (J.B.C., December, 1915); brown cystidia, locality not known.

143b. POLYPORUS GILVUS var. INAMŒNUS Montague.

Polyporus inamœnus, Lloyd, Syn. of the Genus Polyporus, p. 348.

'This is an indurated subfomes form of *Polyporus gilvus*. Sometimes it shows distinct pore layers. *Polyporus gilvus* takes this form more commonly in warm countries, but we have specimens from California and Dakota.'—Lloyd.

Lloyd records this for Australia (E. Jarvis).

143c. POLYPORUS GILVUS var. LICNOIDES Mont.

Polyporus licnoides, Lloyd, Syn. of the Polyporus, p. 349.

'This is the most pronounced, tropical form. It is thin (type 2 mm.), more flaccid, and tends towards Polystictus. In the most highly specialized 'type' form there are smooth, reddish zones in the pileus, but they are present and absent in the same collection.'—Lloyd.

We have specimens, identified by Lloyd, collected at the Spit, Sydney, in July, 1916 (acuminate brown setæ, 30 to 34 × 7 to 8·5μ); also on a fallen log near Eulah Creek, Narrabri, in November, 1916.

144. POLYPORUS RADIATUS Sow.

'Pileus dimidiate, sessile, triquetrous, with thin margin. Surface minutely velutinate, at length strongly rugulose, radiate. Flesh hard, dry, yellowish-brown. Pores concolorous, small, about $\frac{1}{2}$ cm. long, with mouths that glisten silvery when turned to the light. Setæ rare, short, thick. Spores hyaline, $4-5 \times 5-6\mu$.'—Lloyd.

Lloyd has referred, with doubt, a specimen collected by one of us at the base of a *Leptospermum* bush on Milson

Island, Hawkesbury River (March—spores white, pear-shaped, 3·6 to 4·2 × 2·5μ).

145. Polyporus dryadeus Persoon.

'Pileus sessile, often large, a foot even in diameter, 2 to 3 inches thick. Surface with a thin but distinct crust, brown. Context medium, soft, reddish-brown colour (Sudan brown), with a sheen. Pores small, round, subconcolorous, 1 to 2 cm. long. Setæ straight, rare, 8 × 40 mic. Spores globose, smooth, hyaline or pale coloured, 7 to 8 mic.'–Lloyd.

One of us (J.B.C.) has collected this species growing about ten feet up on the trunk of a Eucalypt in the Mount Lofty Range, South Australia, in July 1914. Though it has not been recorded for New South Wales, its description is given here, as in other parts of the world it is a destructive timber parasite. Lloyd, in identifying our specimen, states:—'This grew on Eucalypts and is the first specimen known from Australia. It appears at first sight to the eye a little different from the European plant, surface with a pale more pronounced crust but microscopic features agree exactly. There is an indication on the specimen of a mycelial core, a feature only known on the related species *Polyporus corruscans* of Europe.' The spores of our specimen are oval, 8·5 to 8·8 × 6 to 7μ.

Fourth General Division—Context and spores coloured. Spores not truncate.

Section 92. Context pale (white?) or isabelline. Setæ none.

146. Polyporus Dielsii Hennings.

Lloyd says this is a very large species, only known from a piece at Berlin, which came from Australia.

Section 93. Context yellow. Setæ none. No Australian species recorded.

Section 94. Context brown, setæ none.

A—Plants very minute.

No Australian species recorded.

B—Pores large.

147. Polyporus decipiens Berk.

Polyporus decipiens (Berk.), Lloyd, Apus Polyporus, p. 355, (1915) fig. 390; Letter 60, p. 4 (Note 34) 1915.

Syn. *Hexagona decipiens* Berk., Journ. Linn. Soc., Bot. xiii, p. 166 (1873); Cooke, Handb. No. 894; *Trametes decipiens* Berk., Bres. MS. in Herb. Kew; Wakefield, Kew Bull. (1915) 366.

'Pileus sessile, dimidiate, triquetrous, unicolorous, dark brown. Surface brown, hard, tomentose, rigid. Flesh hard, firm, brown, descending into the pores. Pores rigid, trametoid, 4 to 8 mm. long, round or elongated, large, 1 to 2 mm. Setæ none. Spores abundant, large, elliptical, 8 × 16 mic., deeply coloured.'—Lloyd.

We have the following specimens:—On trunk of living tree, Peakhurst (E.C., July, 1901); on *Acacia doratoxylon*, Mount Boppy; Casuarina, Western Line (L. Abrahams, October, 1911); on log, Milson Island, Hawkesbury River (J.B.C., July, 1912), identified by Lloyd as *Hexagona decipiens*, who, in placing it under *Polyporus* points out that no true *Hexagona* has coloured spores; on fallen log, Kurrajong Heights (J.B.C., August, 1912); Wellington (J.B.C., October, 1914)—spores brown, 15·5 to 19 × 6·5 to 7·5μ; locality not noted; Hornsby (W. F. Blakely, June, 1914). The Hornsby specimens were determined by Mr. Lloyd. The specimens recorded by Miss Wakefield, were collected at Moruya, and are stated to be well-marked by the large, elliptical, brown spores, 15 – 20 × 7·5 – 9μ.

We have also specimens from Bumberry, near Manildra, September, spores brown, 15·5 to 17 × 8·5 to 10·4. Mr. C. Brittlebank has forwarded us Victorian specimens from the Mallee, collected by J. Dickson on *Casuarina Luehmanni*, in November, 1916, spores brown, 17 to 20 × 8 to 11μ.

C—Pores small.

149. Polyporus spadiceus Berk.

As *Fomes spadiceus*, recorded by Cooke (No. 618) for Queensland.

150. Polyporus pubertatis Yasuda.

'Pileus sessile (3 × 6 × 1 ½ cm.), unicolorous dark brown (verona brown). Surface minutely pubescent, soft to touch. Flesh concolorous, hard, slightly punky. Pores minute, round, 3 to 5 mm. long, with concolorous tissue and mouths. Setæ, none. Spores abundant, 3 × 5μ, elliptical, pale coloured.'—Lloyd. A Japanese species.

Lloyd has identified a specimen for us obtained on a fallen log in Mummulgum Brush, near Casino, in December 1916—spores pallid brownish, 4 × 2·5μ; no setæ.

Section 95. Context brown. Setæ present.

A—Surface tomentose or hispid.

151. Polyporus hispidus Baglietto.

Recorded by Cooke (No. 648) for Queensland.

152. Polyporus cuticularis Bulliard.

'Pileus applanate, dimidiate, imbricate. Surface tomentose with appressed, brown hairs, zonate when young. Context varying from 3 to 10 mm. thick, hard, fibrillose, ferruginous brown (Sudan brown). Pores small, varying in size, angular or irregular, 5 × 8 mm. long, with concolorous tissue. Mouths often stuffed or overgrown, when fresh strongly glancing. Setæ very scanty, sometimes not found at all, straight. Spores abundant, globose or subglobose, deeply coloured, largest 7 × 7 to 8μ, many smaller, 4 to 5 × 5 to 6μ.'—Lloyd. Common on beech and maple logs in America.

Lloyd has identified a specimen for us found growing on a living trunk at Mummulgum, near Casino, in December,

1916—spores dark brown, oval, 5 to 6 × 3·5μ; one brown acuminate seta seen.

153. POLYPORUS CORRUSCANS Fr. (P. RHEADES Pers.).

'Pileus sessile, dimidiate, subglobose or ungulate, often imbricate. Surface tomentose, velutinate, with short, fine brown hairs. There is at first developed a mycelial core, hard, amorphous, grumous, dark brown. Flesh fibrillose, ferruginous brown (Sudan brown). At first zonate, soft, watery and spongy, at length dry, hard. Pores small, round, about 1 cm. long, with tissue concolorous with the context, when fresh the mouths silvery and glancing. Hyphæ deeply coloured. Setæ scanty and rare, often not found. Spores very abundant, globose or compressed globose, $5-7 \times 6-7\mu$, deeply coloured, smooth.'—Lloyd.

Lloyd has identified specimens from W. W. Froggatt (Letter No. 63, Note 472, 1916), presumably from New South Wales.

B—Surface smooth or at length smooth.

154. POLYPORUS PATOUILLARDII Rick.

Polyporus Patouillardii Lloyd, Letter No. 56 (Note 253), 1915; Letter No. 58 (Note 268) 1915; Synopsis, Sect. Apus of the Genus Polyporus (1915) 365.

'Pileus sessile, applanate, 2 – 3 cm. thick. Surface smooth, brown, dull. Flesh brittle, hard, faintly zonate, with a satiny lustre, dark brown (antique brown). Pores small, round, $1-1\frac{1}{2}$ cm. deep, pale yellowish-brown, more yellow than the context. Imbedded in the pore tissue are thick, deeply coloured, rigid hyphæ. Setæ scattered, thick, straight, projecting 20 mic. Spores abundant, elliptical, 4 – 6 mic., pale colured.

Rev. Mr. Rick has named and distributed this from Brazil (No. 25 as *lineatoscaber*) and we have specimens to correspond. It has peculiar coloured flesh, with a lustre on

the order of *Polyporus dryadeus.* Many polypores have what is called 'glancing' pore mouths, when the shade of colour appears different according to the angle of the light. This is the only species in which we have noted the same effect on the context. The peculiar setæ found in the pore tissue are not found in the context. Other species of this same genus (*Oxyuris*) have these setæ in both context and pore tissue. This plant from the American tropics is only recently known from Brazil, but has lately reached me from E. D. Merrill, Philippines, G. Yamada, Japan, and E. Cheel, Australia.'—Lloyd.

In Lloyd's Note 268, the following reference is made to this specimen from Australia:—'*Polyporus Patouillardii*, sent by E. Cheel, Australia. This is the first specimen known from Australia, and its occurrence is of much interest. Very recently, 1907, it was named from Brazil by Rick, then we got specimens from Japan, G. Yamada, then from Philippines, E. D. Merrill, and now it comes from Australia. (Compare Synopsis Polyporus, page 366, and Note 253, Letter 56.) The Australian plant differs slightly from the Brazilian plant, in fact enough to make a 'new species' if one wants to multiply the species, but the difference can only be noted on comparison, and of course, from one specimen we cannot say it is constant. The context of the Australian plant is coarser to the eye, and the microscope shows the hyphæ slightly thicker and of much deeper colour. The different hyphæ of the pore tissue are not in evidence, and I find no setæ. The spores are slightly smaller, $3 \times 5\mu$. These differences would ordinarily constitute 'a species,' but I feel it is practically the same plant, and it would only obscure the subject to propose one. The history of *Polyporus Patouillardii* which has all developed in the last three years, is evidence of what little is known relatively about foreign polypores.'

The specimen was obtained at Stanwell Park (H. Stephens, October, 1913).

Section 96. Context brown. Light, spongy, fibrillose. Setæ none.

155. POLYPORUS FRUTICUM Berk.

Recorded by Cooke (No. 649) for Queensland.

Fifth General Division—Polyporus—Ganodermus. Context brown; spores coloured, truncate.

Section 97. Context soft, spongy.

No Australian species recorded.

Section 98. Context firm, not spongy.

A—Spores rough.

No Australian species recorded.

B—Spores smooth or slightly rough.

No Australian species recorded.

Section 99. Polyporus (Amaurodermus).

No Australian species recorded.

IV. HEXAGONA.

Section I.—Setosa. Surface clothed with dense branched hairs.

Section II.—Velutina. Surface with fine soft pubescence.

Section III—Ungulaformis (hoof-shaped). Thick, hard, and long pores.

Section IV—Applanata. Pileus generally flattened and texture usually softer.

Section V—Tenuis. Pileus very thin, with rather small shallow pores.

Section VI—Pallida. Context white or pale ochraceous.

Section VII—Pseudofavola. Pileus more or less fleshy, tough.

Section I—Setosa.

156. HEXAGONA APIARIA (Pers.), Lloyd.

Syn. *H. Wightii* Klotsch in Cooke's Handb. Aust. Fungi, No. 882; Baker, in Proc. Linn. Soc. N.S.W., XXII, p. 238, (1897).

The specimens recorded by Mr. Baker are from Lismore, New South Wales, collected by Mr. Baeuerlen. We have not examined these.

157. HEXAGONA CRINIGERA Fr.

Cheel, Reports, 1911 (1912), 12.

We have a solitary specimen of this species from Port Moresby, collected by A. E. Pratt in July, 1911.

Section II—Velutina.

No Australian species recorded.

Section III—Ungulaformis

158. HEXAGONA GUNNII Hook.

Hooker, Journ. Bot. IV, p. 57; Cooke, Handb. Aust. Fungi No. 887; Lloyd, Syn. Gen. Hexagona, p. 15 (1910); Cheel, Reports, 1911 (1912) 12.

Lloyd has examined the Australian specimens at Kew, England, where there are several collections made in Tasmania and Australia. In the National Herbarium, Sydney, and in our private collections there are specimens from the following localities:—Adelaide, South Australia (J.B.C., 1898); Hobart, Tasmania, on *Eucalyptus viminalis* Labill., (E.C., March, 1910); Conjola, on Blackbutt (W. Heron, 1891); Cobar, (L. Abrahams, July, 1911); Parramatta, on Eucalyptus trunks (J.B.C., July, 1912), identified by Lloyd.

Section IV—Applanata.

No Australian species recorded.

Section V—Tenuis.

159. HEXAGONA TENUIS Hook.

Hooker in Kunth. Syn. 10; Cooke, Handb. Aust. Fungi No. 891; Cheel, Proc. Linn. Soc. N.S.W., XXXII, p. 203, 1907, Reports 1913 (1914) 17; Lloyd, Letter No. 19, 1908, and Syn. Gen. Hexagona, p. 23, 1910.

This is a very common species, usually found on dead branches. It has a very wide range, having been recorded

by Cooke (*l.c.*) from Queensland, South Australia, North East Australia and Cape York. In the National Herbarium there are specimens from the following localities:—Hill Top and Hazelbrook (J. H. Maiden, 1903 and 1906) on Coachwood (*Ceratopetalum apetalum*); Pittwater (A. Maclellan, September, 1907); Helensburgh (W. Craigie, August, 1909); Hornsby and Lilyvale (A. A. Hamilton, October, 1910); Willoughby (A. G. Hamilton, July, 1910); Grose Vale, (Miss Campbell, September, 1912, determined by Lloyd). We have also specimens from Mount Wilson and from the Hawkesbury River, both taken in June. The shed spores of New South Wales plants are elongated, sausage-shaped, granular, 13·8 to 15·5 × 5μ.

160. Hexagona tenuis var. umbrinella Fr.

Lloyd (Letter 63, 1916) has identified for us as *H. umbrinella*, specimens from Helensburgh (A. A. Hamilton, October, 1913). He considers *H. umbrinella* as a form of *H. tenuis* with a dark reddish-brown rugulose surface.

161. Hexagona tenuis var. subtenuis Berk.

Cooke, Handb. Aust. Fungi, No. 891; Baker, Proc. Linn. Soc. N.S.W., xxii, p. 238, 1897.

This, according to Lloyd (Syn. Gen. Hexagona, p. 26), 'was originally named by Berkeley from India.' The Australian specimens recorded under this name are very probably intermediate forms between *H. tenuis* and *H. rigida.*

The following are probably thick forms of *Hexagona tenuis*, and may be *H. subtenuis* of Berkeley. On silky oak *(Grevillea robusta)* Hyde Park and Botanic Gardens (C. Robbie, A. Grant and E.C.); Leura (A. A. Hamilton, August, 1910); Cronulla (J. Staer, July, 1910); Blackheath (Rev. W. W. Watts, July, 1911); Tuggerah Lakes, N.S.W., and Eumundi, Q., (J. Staer, September, 1912); Milson

Island (J.B.C., July, 1912); Smoky Cape (F. W. Raffills, October, 1905).

162. Hexagona rigida Berk.

Berk., Journ. Linn. Soc. (Bot.) xvi, p. 54, 1878; Cooke, Handb. Aust. Fungi, No. 887.

This was originally described by Berkeley from specimens collected at Lord Howe Island.

In the National Herbarium, Sydney, there are specimens from Lord Howe Island collected by Mr. J. H. Maiden in April, 1898, and Rev. W. W. Watts in July, 1911, also specimens received through the Curator of the Australian Museum in 1897, which we feel sure belong to this species.

163. Hexagona similis Berk.

Berk., Hook. Lond. Journ. Bot., v, p. 4, 1846; Cooke, Hankb. Aust. Fungi, No. 893; Lloyd, Letters No. 38, p. 2, and 60, p. 4, 1915, and Syn. Gen. Hexagona, p. 27, 1910.

We have specimens of this species from Helensburgh, collected by A. A. Hamilton in October, 1913, and from Cowan Creek, Hornsby, on dead Casuarina, collected by W. F. Blakely in June, 1915. Specimens of the latter collection have been identified as this species by Lloyd.

Section VI—Pallida.

No Australian species recorded.

Section VII—Pseudofavola.

No Australian species recorded.

[1] [164. Hexagona olivacea.

Lloyd (Letter 53, p. 14, 1914) has identified a specimen from Dr. Stoward, Western Australia, as *H. olivacea*. We do not find the species mentioned in his synopsis of the genus *Hexagona*.]

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[1] Position under Section unknown.

Merulius.

Merulius lacrymans Sch.

Specimens of this are recorded by Cooke in Handb. of Australian Fungi, for Queensland and Western Australia. We have no authentic specimens for this State so far, although it may possibly be found here when the whole of the specimens in our collections have been worked up.

Merulius umbrinus Fr.

Specimens of this species have been identified by Lloyd, collected at Wamberal by one of us (E.C.) in April, 1911, Mr. Lloyd remarks, 'The plant has the same coloration and the same general nature as *Merulius lacrymans*, but *umbrinus* is supposed to be a thinner species.'

V. LISTS OF AUSTRALIAN POLYPORES OF THE GENERA FOMES, POLYPORUS AND HEXAGONA.

Compiled from Lloyd's Works with additions from Cooke's Handbook of Australian Fungi.

(* indicates that Australian specimens have been seen or identified by Lloyd. These numbers do not necessarily correspond with those given in the text.)

I.—Stipitate Polypores.

1*	*Polyporus*	*(Ganodermus)*	*lucidus* var. *japonicus*, N.S.W.
2	,,	,,	*amboinensis*
3*	,,	,,	*fornicatus*
4*	,,	,,	*ochrolaccatus*, New Guinea
5*	*Polyporus*	*(Amaurodermus)*	*rudis*, N.S.W. (Records of *A. rugosus* probably refer to this.)
6	,,	,,	*leptopus ?*
7*	*Polyporus*	*(Lignosus)*	*superpositus*, N.S.W.
8	,,	,,	*scopulosus*
9*	*Polyporus*	*(Petaloides)*	*fusco-maculatus ?*
10	,,	,,	*annulatus ?* N.S.W.

11*	*Polyporus*	(*Petaloides*)	*rhipidium*, N.S.W.
12	,,	,,	*rubidus*, N.S.W.
13	,,	,,	*brunneolus*
14	,,	,,	*petalodes*
15*	,,	,,	*gallo-pavonis*
16*	,,	,,	*grammocephalus*, N.S.W.
17*	,,	(*Petaloides* ?)	*platotis*
18*	,,	(*Petaloides*)	*fusco-lineatus*
19*	,,	,,	*dorcadideus*
20*	,,	,,	*megalosporus*, N.S.W.
21*	,,	,,	*obniger*, N.S.W.
22*	,,	,,	*pocula*
23	*Polystictus*	(*Petaloides*)	*mutabilis*
24	,,	,,	*obovatus*
25*	,,	,,	*stereinus*, N.S.W.
26	,,	,,	*affinis*, N.S.W.
27*	,,	,,	*luteus*, N.S.W.
28*	,,	,,	*flabelliformis*, N.S.W.
29*	,,	,,	*subfulvus*, N.S.W.
30	,,	,,	*sanguineus*
31	,,	,,	*cinnabarinus*
32	,,	,,	*Pentzkei*
33	,,	,,	*intonsus*
34	,,	,,	*peroxydatus*, N.S.W.
35	,,	,,	*libum* (type inadequate), N.S.W.
36	,,	,,	*verniciflmus* (type inadequate)
37*	*Polyporus*	(*Merismus*)	*Berkeleyi*, N.S.W.
38	,,	,,	*frondosus*
39*	,,	,,	*anthracophilus*
40*	,,	,,	*multiplex*
41*	*Polystictus*	,,	*Ridleyi*
42	*Polyporus*	,,	*sulphureus*
42a*	,,	,,	,, var. *Wilsonianus*
43	,,	,,	*retiporus ?*
44	,,	,,	*intybaceus*
45	,,	,,	*scabriusculus*

46	*Polyporus*	(*Merismus*)	*lætus*
47	„	„	*rosettus*, N.S.W.
48*	*Polyporus*	(*Spongiosus*)	*rufescens*
49*	„	„	*hystriculus*
50*	„	„	*Schweinitzii*, N.S.W.
51	*Polystictus*	„	*tomentosus*
52	*Polyporus*	(*Pelleporus*)	*luteo-nitidus*
53	*Polystictus*	„	*perennis*
54	„	„	*oblectans*, N.S.W.
55*	*Polyporus*	(*Ovinus*)	*mylittæ*, N.S.W.
56	„	„	*minor-mylittæ*, N.S.W.
57	„	„	*ovinus*
58	„	„	*confluens*
59	„	„	*pes-capræ*
60*	„	„	*squamosus*, N.S.W. ?
60a*	„	„	„ var. *lentinoides*, N.S.W.
61	„	„	*tumulosus*
62	„	(*Ovinus ?*)	*basilapiloides* (*Laccocephalum basilapiloides*)
63*	„	(*Ovinus*)	*tasmanicus*, N.S.W.
64*	„	„	*Hartmanni*, N.S.W.
65	„	„	*myclodes*
66*	*Polyporus*	(*Lentus*)	*tricholoma*
67	„	„	*brumalis*
68*	„	„	*virgatus*, N.S.W.
69	„	„	*xanthopus*, N.S.W.
70	„	„	*arcularius*, N.S.W.
71	„	„	*lentus*
72*	*Polyporus*	(*Melanopus*)	*varius*, N.S.W.
72a*	„	„	„ var. *Blanchetianus*, N.S.W.
72b*	„	„	„ var. *Pancheri*, N.S.W.
73	„	„	*melanopus*
74	*Polystictus*	„	*nephridius*
75	*Polyporus*	„	*pusillus*
76*	„	„	*Guilfoylei*
77	„	„	*glabratus*

II.—Fomes.

78	*Fomes*	*connatus*
79	,,	*annosus*
80*	,,	*Clelandii*, N.S.W.
81*	,,	*Ohiensis*, N.S.W.
82	,,	*pinicola*, N.S.W.
83*	,,	*hemitephrus*, N.S.W.
84*	,,	*semitostus?*
85	,,	*dochmius*
86*	,,	*concavus*
87	,,	*ferreus*
88	*Trametes*	*carnea*
89*	,,	*Feei*, N.S.W.
90*	,,	*lilacino-gilva*, N.S.W.
90a*	,,	,, ,, var. *Stowardii*
90b*	,,	,, ,, ,, *eucalypti*
91	,,	*plebeia*
92	,,	*rosea*
93*	,,	*cupreo-rosea*
94	*Fomes*	*lignosus*
95*	,,	*kermes*
96	,,	*inflexibilis*
97	,,	*exotephrus*
98	,,	*fomentarius*, N.S.W.
99	,,	*caliginosus (*or *endapalus)*, N.S.W.
100*	,,	*pomaceus*
101*	,,	*robustus*, N.S.W.
102*	,,	*setulosus*
103*	,,	*conchatus*, N.S.W.
103a	,,	,, var. *salicinus*
104*	,,	*igniarius ?* N.S.W.
105*	,,	*Robinsoniae (squarrosus)*, N.S.W.
106*	,,	*lineato-scaber*, N.S.W.
107*	,,	*rimosus*, N.S.W.
107a*	,,	,, var. *Niaoulii*, N.S.W.
108*	,,	*scaber*

109 *Fomes pectinatus*
110 „ *pullus*
111* „ *Tepperii*, N.S.W.
112* „ *Yucatensis*, N.S.W.
113 „ *linteus?* N.S.W.
114* „ *applanatus*, N.S.W.
114a* „ „ var. *leucophæus*
114b* „ „ „ *australis*, N.S.W.
114c* „ „ „ *oroflavus*
114d* „ „ „ *nigrolaccatus*

The following in Cooke's List are not referred to by Lloyd—they are probably Porias.

115 *Fomes obliquus* Pers., N.S.W.
116 „ *luridus* Kalk., N.S.W.

III.—Section Apus of the Genus Polyporus.

117 *Polyporus betulinus*
118 „ *albellus*, N.S.W.
119* „ *portentosus*, N.S.W.
120* „ *tephronotus*, N.S.W.
121* „ *pelliculosus*
122* „ *eucalyptorum*, N.S.W.
123 „ *immaculatus*
124* „ *cretaceus*
125* „ *fumosus*, N.S.W.
126 „ *epileucus*
127* „ *ochroleucus*, N.S.W.
128 *Trametes cubensis*
129 *Polyporus fragilis*
130* „ *cæsius*, N.S.W.
131 „ *borealis*
132* „ *pelles*
133 „ *adustus*
134* „ *campylus*
135* „ *australiensis*, N.S.W.
136* „ *dichrous*, N.S.W.

137 *Polyporus rutilans*
138* „ *zonalis*, N.S.W.
138a „ „ var. *rigidus*, N.S.W.
139* „ *semilaccatus*
140* „ *anebus*, N.S.W.
140a „ „ var. *bicolor*, N.S.W.
141* „ *durus*
142* „ *vinosus*, New Guinea
143* „ *subolivaceus*, N.S.W.
144* „ *gilvus*, N.S.W.
144a* „ „ var. *scruposus*, N.S.W.
144b* „ „ „ *inamœnus*
144c* „ „ „ *lichnoides*, N.S.W.
145* „ *radiatus*, N.S.W.
146* „ *dryadeus*
147* „ *Dielsii*
148* „ *decipiens*, N.S.W.
149 „ *spadiceus*
150* „ *pubertatis*, N.S.W.
151 „ *hispidus*
152* „ *cuticularis*, N.S.W.
153* „ *corruscans (P. rheades)*
154* „ *Patouillardii*, N.S.W.
155* „ *fruticum*

The following species in Cooke's Handbook are not referred to by Lloyd :—

156 *Polyporus corrivalis*
157 „ *Gunnii*
158 „ *argentatus*
159 „ *fœdatus*

To these may be added :—

160 *Polyporus strumosus* (perhaps *P. adustus*)
161 „ *ascoboloides* (type destroyed)

IV.—Hexagona.

162 *Hexagona apiaria*, N.S.W.
163 „ *hirta*

164*	*Hexagona Gunnii*, N.S.W.			
165	,,	*sulcata* var. *durissima*		
166*	,,	*tenuis*, N.S.W.		
166a	,,	,,	,,	var. *polygramma*
166b*	,,	,,	,,	,, *umbrinella*, N.S.W.
166c	,,	,,	,,	,, *subtenuis*, N.S.W.
167	,,	*rigida*		
168	,,	*similis*, N.S.W.		
169*	,,	*olivacea*		

VI. COOKE'S LISTS OF CERTAIN AUSTRALIAN POLYPORES CORRECTED IN THE LIGHT OF LLOYD'S INVESTIGATIONS.

[In these lists, opposite the species recorded in Cooke, whose number precedes each species, is given the correct identification revealed by C. G. Lloyd's researches.]

I.—Stipitate Polypores.

583	*Polyporus*	*ovinus*	= *P. (Ovinus)*	*ovinus*
584	,,	*pes-capræ*	,,	*pes-capræ*
585	,,	*Hartmanni*	,,	*Hartmanni*
586	,,	*tumulosus*	,,	*tumulosus*
587	,,	*myelodes (myclodes)* unknown (Lloyd)		
588	,,	*lentus*	= *P. (Lentus)*	*lentus*
589	,,	*brumalis*	,,	*brumalis*
590	,,	*cupuliformis*	= *P. (Petaloides)*	*pocula*
591	,,	*arcularius*	= *P. (Lentus)*	*arcularius*
592	,,	*tricholoma*	,,	*tricholoma*
593	,,	*similis*	,,	*tricholoma*, probably (type very scanty)
594	,,	*alveolarius (collybioides)*	= *P. (Lentus)*	*arcularius*
595	,,	*stipitarius*	,,	*tricholoma*
596	,,	*pisiformis*. Type too young and indescribable		
597	,,	*Schweinitzii*	= *P. (Spongiosus)*	*Schweinitzii*
598	,,	*tabulæformis (spectabilis)*	,,	*Schweinitzii*
599	,,	*biennis*	,,	*rufescens*

600	*Polyporus*	*rufescens*	,,	*rufescens*
601	,,	*proteiporus*	,,	*rufescens*
602	,,	*histriculus*	,,	*histriculus*
603	,,	*squamosus* = *P. (Ovinus) squamosus*		
604	,,	*melanopus* = *P. (Melanopus) melanopus*		
605	,,	*picipes*	,,	*varius*, black form
606	,,	*Strangeri*	,,	*dictyopus* probably, type unknown
607	,,	*infernalis*	,,	*dictyopus*, a form of *varius*
608	,,	*varius*	,,	*varius*
609	,,	*elegans*	,,	*elegans*
	,,	,, var. *nummularius*		
610	,,	*glabratus*. Type unknown		
611	,,	*Guilfoylei* = *P. (Melanopus) Guilfoylei*		
612	,,	*Leprieurii*	,,	*Leprieurii*. New Guinea only.
613	,,	*dictyopus*	,,	*dictyopus*, a form of *varius*
613 (bis)	,,	*petaloides* = *P. (Petaloides) petalodes*		
614	,,	*grammocephalus*	,,	*grammocephalus*
	,,	,,		var. *Emerici*
	,,	,,		,, *Muelleri*
615	,,	*platotis* = *P. (Section ?) platotis*		
616	,,	*dorcadideus* = *P. (Petaloides) dorcadideus*		
617	,,	*fusco-lineatus*	,,	*fusco-lineatus*
618	,,	*frondosus* = *P. (Merismus) frondosus*		
619	,,	*intybaceus*. Not mentioned by Lloyd		
620	,,	*confluens* = *P. (Ovinus) confluens*		
621	,,	*scabriusculus*. No type exists		
622	,,	*anthracophilus* = *P. (Merismus) anthracophilus*		
623	,,	*lætus*. Not mentioned by Lloyd		
624	,,	*sulfureus* = *P. (Merismus) sulphureus*		
625	,,	*retiporus*	,,	*sulphureus* var. *retiporus (P. retiporus ?)* and *P. australiensis*.

661 *Polyporus subzonalis* = *P. (Petaloides) gallopavonis* pale form.
668 *Fomes nigripes* = *P. (Amaurodermus) leptopus* probably, no type exists
669 „ *rudis* „ *rudis*
670 „ *pullatus* Type too poor for recognition
671 „ *rugosus* = *P. (Amaurodermus) rudis* probably, when referring to Australian specimens
672 „ *amboinensis* Probably not the true *P. (Ganodermus) amboinensis*
„ „ var. *gibbosus*
673 „ *lucidus* = *P. (Ganodermus) lucidus*
674 „ *superpositus* = *P. (Lignosus) superpositus*
714 „ *scopulosus* „ *scopulosus*
724 *Polystictus tomentosus* = *P. (Spongiosus) tomentosus*
725 „ *luteonitidus* = *P. (Pelleporus) luteonitidus*
726 „ *perennis* „ *perennis*
727 „ *cinnamoneus* „ *oblectans*, probably, as referring to Australian specimens.
728 „ *oblectans* = *P. (Pelleporus) oblectans*
729 „ *bulbipes* (*cladonia*, *perdurans*) = *P.* (*Pelleporus*) *oblectans*
730 „ *parvulus* = *P.* (*Pelleporus*) *oblectans*, probably, as referring to Australian specimens
731 „ *quadrans* = *P.* (*Lentus*) *zanthopus*, probably, no type exists
732 „ *zanthopus* (*cupreo-nitens*) = *P.* (*Lentus*) *zanthopus*
733 „ *flabelliformis* = *P.* (*Petaloides*) *flabelliformis*
734 „ *porphyrites* „ *luteus*, probably
735 „ *Adami* (*dilatatus*) „ *obovatus*
736 „ *mutabilis* „ *mutabilis*
737 „ *luteus* „ *luteus*
738 „ *carneo-niger* „ *carneo-niger*
739 „ *nephridius* = *P.* (*Melanopus*) *nephridius*
740 „ *affinis* = *P.* (*Petaloides*) *affinis*
741 „ *stereinus* (*cognatus*) = *P.* (*Petaloides*) *stereinus*
742 „ *intonsus* No type exists

743 *Polystictus brunneolus* = *P.* (*Petaloides*) *brunneolus*
744 „ *peroxydatus* No type exists
745 „ *libum* Type inadequate
746 „ *sanguineus* = *P.* (*Petaloides*) *sanguineus*
747 „ *rasipes* „ *obovatus*
770 „ *cinnabarinus* „ *cinnabarinus*
790 „ *vernicifluus* Type inadequate
895 *Favolus squamifer* = *P.* (*Lentus*) *arcularius*, probably.
896 „ *Boucheanus* = *P.* (*Ovinus*) *squamosus* var. *Boucheanus*
898 „ *pusillus* = *P.* (*Melanopus*) *pusillus*
899 „ *rhipidium* = *P.* (*Petaloides*) *rhipidium*
1351 *Mylitta australis* = *P.* (*Ovinus*) *mylittæ*

II.—Fomes.

658 *Polyporus hypopolius* = *Fomes annosus*, from the description.
662 „ *lignosus* „ *lignosus*
664 „ *plebius* = *Trametes plebeia*
676 *Fomes scansilis* = *Fomes australis*, diseased form.
677 „ *marginatus* „ *pinicola*
678 „ *dochmius* „ *dochmius*
679 „ *concavus* „ *concavus*
680 „ *conchatus* „ *conchatus*
681 „ *australis* „ *applanatus*, var. *australis*
„ „ var. *arculatum*
682 „ *chilensis* = *Fomes australis*
683 „ *applanatus* „ *applanatus*
684 „ *orbiformis* Type inadequate
685 „ *nigrolaccatus* = *Fomes nigrolaccatus*
686 „ *fomentarius* „ *fomentarius*
687 „ *igniarius* = *Fomes igniarius*. Australian references are probably to *F. rimosus* or *F. robustus* (J.B.C. and E.C.)
688 „ *rimosus* = *Fomes rimosus*
689 „ *fulvus* Original figure and description inadequate.
690 „ *gryphæformis* No type exists.
691 „ *salicinus* = *F. conchatus*, var. *salicinus*

692 *Fomes hemileucus* As Polyporus, Lloyd says the description was applied to three species, viz. *Trametes cubensis*, *Polyporus modestus* and *P. valenzuelianus*.

693 „ *exotephrus* = *F. exotephrus*

694 „ *contrarius* Probably *F. annosus*

695 „ *tasmanicus* Probably *F. semitostus* Type very poor

696 „ *pullus* = *F. pullus*

697 „ *lineato-scaber* = *F. lineato-scaber*

698 „ *spadiceus* = *Polyporus spadiceus*

699 „ *inflexibilis* (*Polyporus recurvus*) = *F. inflexibilis*

700 „ *linteus* „ *linteus*

701 „ *pectinatus* „ *pectinatus*

702 „ *rubiginosus* (*Polyporus Laurencii*) = *Polyporus gilvus*

703 „ *Gourliei* = *Polystictus occidentalis* Type very poor.

704 „ *endapalus* = *F. endapalus*, possibly young *F. caliginosus*

705 „ *Curreyi* = *Trametes strigata*

706 „ *strigatus* „ „ (?, J.B.C and E.C.)

707 „ *ponderosus* = *Polyporus durus*, probably

708 „ *annosus* = *F. annosus*

709 „ *compressus* = *Polyporus ochroleucus*

710 „ *connatus* = *F. connatus*

711 „ *hemitephrus* „ *hemitephrus*

712 „ *Palliseri* ? What species

713 „ *ferreus* = *F. ferreus*

714 „ *scopulosus* = *Polyporus* (*Lignosus*) *scopulosus*

715 „ *oblinitus* „ *bicolor*

716 „ *fasciatus* ? What species

717 „ *carneus* = *Trametes carnea*

718 „ *cinereo-fuscus* = *Polyporus semilaccatus*, discoloured.

719 „ *homalopilus* (*Polyporus carneofulvus*) = *P. gilvus*

720 „ *incrassatus* „ *reniformis* = *F. leucophæus*

721 „ *obliquus* Not referred to by Lloyd, probably a *Poria*

722 „ *luridus* „ „ „ „ „ „ „ „

723 „ *bistratosus* Type a *Poria*

III.—Polyporus (Apus).

626 *Polyporus tephronotus* = *P. tephronotus*

627 ,, *epileucus* ,, *epileucus*

628 ,, *corrivalis* No reference by Lloyd

629 ,, *verecundus* (Fiji) = *P. immaculatus*, probably

630 ,, *semidigitaliformis* Type too poor

631 ,, *Gunnii* No reference by Lloyd

632 ,, *angustus* = *P. tephronotus*

633 ,, *fragilis* ,, *fragilis*

634 ,, *stypticus* ,, *australiensis* [vide Wakefield, Kew Bull. (1914), 157]

635 ,, *chioneus* ,, *albellus*

636 ,, *argentatus* No reference by Lloyd

637 ,, *campylus* = *P. campylus*

638 ,, *nidulans* ,, *rutilans*

639 ,, *fœdatus* No reference by Lloyd

640 ,, *rubidus* = *P. rubidus*

641 ,, *gilvus* ,, *gilvus*

642 ,, *scruposus* ,, *scruposus*, a form of *P. gilvus*

643 ,, *isidioides* (= *P. stenoloma*) = *P. scruposus*

644 ,, *demissus* = *P. fumosus*, apparently

645 ,, *rhinocephalus* = *P. fumosus*

646 ,, *adustus* ,, *adustus*

647 ,, *dichrous* ,, *dichrous*

648 ,, *hispidus* ,, *hispidus*

649 ,, *fruticum* ,, *fruticum*

650 ,, *pelliculosus* ,, *pelliculosus*

651 ,, *spiculifer* ,, ,, as a form

652 ,, *borealis* ,, *borealis*

653 ,, *substuppeus* The Australian specimens evidently differ from the type.

654 ,, *betulinus* = *P. betulinus*

655 ,, *portentosus* ,, *portentosus*, some records probably to *P. australiensis*

656 ,, *eucalyptorum* = *P. eucalyptorum*

657 *Polyporus strumosus* = *P. strumosus* (perhaps *P. adustus*)
658 „ *hypopolius* From the description, *Fomes annosus*
659 „ *cartilagineus* = *P. durus*
660 „ *zonalis* „ *zonalis*
661 „ *subzonalis* „ *gallo-pavonis*, pale form (Stipitate Polypore)
662 „ *lignosus* = *Fomes lignosus*
663 „ *cubensis* = *Trametes cubensis*
664 „ *plebius* „ *plebeia*
665 „ *testudo* = *P. durus*
666 „ *anebus* „ *anebus*
667 „ *ascoboloides* Type destroyed
698 *Fomes spadiceus* = *P. spadiceus*
702 „ *rubiginosus* (*Polyporus Laurencii*) = *P. gilvus*
707 „ *ponderosus* = *P. durus*, probably
709 „ *compressus* „ *ochroleucus*
715 „ *oblinitus* „ *bicolor*
716 „ *homalopilus* (*Polyporus carneofulvus*) = *P. gilvus*.
847 *Trametes* (*Polyporus*) *ochroleucus* = *P. ochroleucus*

IV.—Hexagona.

882 *Hexagona Wrightii* = *Hexagona apiaria*
883 „ *crinigera* „ *hirta*
884 „ *durissima* „ *sulcata* var. *durissima*
885 „ *Muelleri* „ *rigida*
886 „ *sericea* = *Polystictus villosus*
887 „ *Gunnii* = *Hexagona Gunnii*
888 „ *rigida* „ *rigida*
889 „ *umbrinella* „ *tenuis*, var. *umbrinella*
890 „ *discolor* (*Favolus discolor*) No type exists
891 „ *tenuis* = *Hexagona tenuis*
„ „ var. *subtenuis* = *Hexagona tenuis*, var. *subtenuis*
892 „ *polygramma* = *Hexagona tenuis* var. *polygramma*
893 „ *similis* „ *similis*
894 „ *decipiens* = *Polyporus decipiens*

A NOVEL APPLICATION OF BROMINE WATER IN SYNTHETIC ORGANIC CHEMISTRY.

By JOHN READ, M.A., Ph.D., and MARGARET MARY WILLIAMS, B.Sc.

[*Read before the Royal Society of N.S. Wales, December 5, 1917.*]

BROMINE water is often used as a test for unsaturation in the molecule of organic substances: decolourisation of the reagent being taken to indicate the presence of the ethylenic or the acetylenic linkage. In the former case, the reaction has usually been assumed to yield solely a dibromo-compound, in accordance with the subjoined general scheme:

$$RR_1C : CR_2R_3 + Br_2 = RR_1CBr \cdot CBrR_2R_3.$$

We have recently been able to show, however, that in the simplest and best-known case of this kind, namely, that of ethylene, the yield of the dibromide may under suitable conditions fall quite low, the bulk of the product being ethylene bromohydrin. In this instance the bromine water is thus an efficient source, not only of bromine, but also of hypobromous acid, and the two reactions represented below take place concurrently:—

$$(1)\ H_2C : CH_2 + Br_2 = H_2CBr \cdot CBrH_2;$$

$$(2)\ H_2C : CH_2 + HO \cdot Br = H_2CBr \cdot CH_2OH.$$

Of the total bromine used in a particular experiment, 37·5 per cent. was converted to ethylene dibromide, 54·4 per cent. was converted to ethylene bromohydrin, and the remaining 8·1 per cent. was eliminated as hydrobromic acid, formed by a partial decomposition of the hypobromous acid to hydrogen bromide and oxygen.[1]

From these figures it is clear that the relative percentage amounts of ethylene converted to dibromide and bromo-

[1] Trans. Chem. Soc., vol. 111 (1917), p. 240.

hydrin were 40·8 and 59·2, respectively. This yield of ethylene bromohydrin is equal to the highest recorded as obtainable by the action of a carefully prepared solution of hypobromous acid upon ethylene.

In view of the laborious and unsatisfactory methods used in the preparation of aqueous solutions of hypochlorous and hypobromous acids and the consequent difficulty of obtaining halogenohydrins directly from unsaturated substances, it was considered of importance to ascertain whether the readily accessible reagent bromine water could be utilised as a source of hypobromous acid in other reactions of a similar type.

The second substance to be selected for investigation in this connection was cinnamic acid. The result in this case was even more striking than with ethylene. We have been able to demonstrate that under suitable conditions cinnamic acid reacts speedily and quantitatively with bromine water, giving a yield of over 80 per cent. of the bromohydrin, *i.e.*, β-phenyl-α-bromohydracrylic acid (commonly known as phenyl-α-bromolactic acid). The other product of the reaction is cinnamic acid dibromide:—

$$(1)\ C_6H_5\cdot CH{:}CH\cdot COOH + HO\cdot Br = C_6H_5\cdot CHOH\cdot CHBr\cdot COOH;$$

$$(2)\ C_6H_5\cdot CH{:}CH\cdot COOH + Br_2 = C_6H_5\cdot CHBr\cdot CHBr\cdot COOH.$$

In order to obtain the maximum yield of the bromohydrin, the cinnamic acid is subjected to vigorous mechanical stirring in contact with about thirty times its weight of ice-cold water, into which a slow current of air charged with bromine vapour is introduced through a perforated glass bulb.

Under these conditions absorption of the bromine takes place rapidly at first, but slackens gradually towards the end of the reaction. A very slight excess over the calcu-

lated quantity of bromine is sufficient to produce a permanent yellow tinge in the liquid.

When the absorption is complete the undissolved cinnamic acid dibromide is separated by filtration from the aqueous liquid, which contains the phenyl-α-bromolactic acid in solution. This substance is readily isolated by extraction with ether, in which it is extremely soluble. The extracted aqueous liquid upon evaporation yields nothing beyond a further small quantity of cinnamic acid dibromide. No bromostyrolene appears to be formed in the reaction.

The purification of phenyl-α-bromolactic acid appears to have been effected in many cases by crystallisation from chloroform, notwithstanding its ready solubility in the cold solvent. The best results are obtained by crystallisation from hot water or from hot benzene or toluene; the acid may also be crystallised from hot ligroin, in which, however, it is only sparingly soluble. The pure acid dissolves to a clear solution in warm water. A slight admixture of cinnamic acid dibromide is sufficient to cause turbidity in such solutions, due to the formation of bromostyrolene; the latter substance may easily be removed by shaking the liquid with light petroleum. It may also be noted that phenyl-α-bromolactic acid separates readily from aqueous solution, in the form of a crystalline precipitate, upon the addition of dilute sulphuric acid.

After one recrystallisation from hot toluene, the acid prepared in the manner described above melted at 120°–122°. Upon adding an equivalent amount of silver nitrate solution to an aqueous solution of the acid, a rapid separation of the crystalline silver salt occurred; titration of the washed and air-dried salt with standard ammonium thiocyanate solution indicated a silver content of 30·28 per cent., the formula $C_9H_8O_3BrAg$ corresponding to 30·68 per cent.

The processes involved in the above reaction are summarised in the appended scheme:—

$$\begin{array}{ccc} Br_2 + H\cdot OH & \rightleftarrows & HBr + HO\cdot Br \\ \downarrow & & \downarrow \\ C_6H_5\cdot CHBr\cdot CHBr\cdot COOH & & C_6H_5\cdot CHOH\cdot CHBr\cdot COOH. \end{array}$$

From this it is apparent that the production of every molecule of bromohydrin involves the formation of a molecule of hydrogen bromide. An excess of hydrobromic acid in the aqueous solution, over the amount arrived at in this way, will be due to decomposition of hypobromous acid into hydrogen bromide and oxygen:—

$$HO\cdot Br = HBr + O.$$

Any wastage of bromine occurring in this way may therefore be traced by estimating the amount of hydrobromic acid in the aqueous solution.

In a carefully conducted operation, 20 grams of cinnamic acid yielded 6·55 grams of cinnamic acid dibromide and 27·1 grams of phenyl-α-bromolactic acid, $C_6H_5\cdot CHOH\cdot CHBr\cdot COOH + H_2O$. It is thus evident that the relative percentage amounts of cinnamic acid converted to dibromide and bromohydrin were 17·1 and 82·9, respectively.

The amount of bromine used in this operation was 21·3 grams; from the data just quoted, the quantities utilised in forming dibromide and bromohydrin were 3·40 and 16·49 grams, respectively. Consequently, the wastage of bromine in the operation, due to the combined causes of decomposition of hypobromous acid and possible diffusion of unaltered halogen, was only 6·6 per cent. This result compares favourably with that obtained with ethylene, in which case the loss of bromine was 8·1 per cent. In both cases, however, since a certain loss of the reaction-products is unavoidable during the process of their isolation, the actual wastage of bromine will be somewhat less than the above figures indicate.

These results having been obtained by using a suspension of cinnamic acid in water, it was next of interest to investigate the action of the reagent upon a neutral solution of a soluble salt of the acid; for this purpose the cinnamic acid was dissolved in the minimum amount of sodium bicarbonate solution. Upon conducting the operation in the manner described above, the bromine was absorbed more rapidly than under the original conditions; and a heavy oil, accompanied by a small amount of crystalline material, separated from the solution. At the end of the reaction, a little dilute sulphuric acid was added to the liquid; the oil was extracted with light petroleum and identified as β-bromostyrolene; the accompanying insoluble solid product proved to consist essentially of cinnamic acid dibromide. A third product, namely, phenyl-α-bromolactic acid, was extracted from the aqueous solution in the usual way by means of ether.

In this way, 20 grams of cinnamic acid yielded 18·7 grams of phenyl-α-bromolactic acid, 1·9 grams of cinnamic acid dibromide, and 10·5 grams of β-bromostyrolene. Thus, the relative percentage amounts of cinnamic acid converted to bromohydrin, dibromide, and β-bromostyrolene were 52·8, 4·6, and 42·6, respectively. The amount of bromine used was 21·3 grams; and an examination of the above figures shows that both the cinnamic acid and the bromine are quantitatively accounted for.

The interesting result is thus revealed that by modifying the conditions of the reaction in this simple manner the yield of bromohydrin falls from 82·9 to 52·8 per cent., the yield of dibromide falls from 17·4 to 4·6 per cent., and a new product, β-bromostyrolene, is formed to the extent of 42·6 per cent. The last named substance being evidently derived by decomposition of the sodium salt of cinnamic

acid dibromide, the complete series of reactions involved may be summarised as follows:—

$$\begin{array}{ccc}
Br_2 + H{\cdot}OH & \rightleftarrows & HBr + HO{\cdot}Br \\
\downarrow & & \downarrow \\
C_6H_5{\cdot}CHBr{\cdot}CHBr{\cdot}COONa & & C_6H_5{\cdot}CHOH{\cdot}CHBr{\cdot}COOH + NaBr \\
\downarrow & & \\
C_6H_5{\cdot}CH{:}CHBr + NaBr + CO_2. & &
\end{array}$$

Quite apart from the general interest of these results the reaction which forms the main subject of this communication is obviously of value as affording a greatly improved method for the preparation of phenyl-α-bromolactic acid. As far as can be ascertained, the only method hitherto available for this purpose has involved the prolonged boiling of cinnamic acid dibromide with water;[1] as is well known, this process is vitiated by the formation of appreciable quantities of bromostyrolene and other by-products.

Phenyl-α-bromolactic acid is of interest because of the ease with which it is converted into phenylacetaldehyde, a substance which, owing to its intense hyacinth odour, is used to some extent in perfumery. The conversion is brought about by treating the phenyl-α-bromolactic acid successively with caustic alkali and dilute sulphuric acid:[2]

$$C_6H_5{\cdot}CHOH{\cdot}CHBr{\cdot}COONa + NaOH = C_6H_5{\cdot}\underbrace{CH{\cdot}CH}_{O}{\cdot}COONa + NaBr + H_2O.$$

$$C_6H_5{\cdot}\underbrace{CH{\cdot}CH}_{O}{\cdot}COOH = C_6H_5{\cdot}CH_2{\cdot}CHO + CO_2.$$

It is apparent that the reaction described above facilitates very considerably the preparation of phenylacetaldehyde from cinnamic acid.

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[1] Glaser, Liebig's Annalen, vol. 147, p. 84.

[2] Erlenmeyer and Lipp, Liebig's Annalen, vol. 219, p. 182.

In continuation of the work outlined in this paper, it is proposed to investigate various other aspects of this method of halogenohydrination. Some possible applications of the reaction in synthetic and other organic chemical processes are worthy of consideration, particularly, it would seem, in connection with the preparation of synthetic drugs. The use of ethylene bromohydrin in the novocaine synthesis is a case in point; further, the grouping $:C(OH)\cdot C(NHR):$, so readily derived from the closely related halogenohydrin grouping, $:C(OH)\cdot C(X):$, appears to possess a considerable degree of physiological importance. In conclusion, it may be remarked that the presence of so many ethylenic constituents in the Australian natural essential oils lends an additional interest to the reaction.

ABSTRACT OF PROCEEDINGS

ABSTRACT OF PROCEEDINGS

OF THE

Royal Society of New South Wales.

MAY 2nd, 1917.

The Annual Meeting, being the three hundred and eighty-eighth General Monthly Meeting of the Society, was held at the Society's House, 5 Elizabeth Street, Sydney, at 8 p.m.

Mr. T. H. HOUGHTON, President, in the Chair.

Forty-nine members and one visitor were present.

The minutes of the General Monthly Meeting of the 6th December, 1916, were read and confirmed.

The certificates of ten candidates for admission as ordinary members were read: three for the second and seven for the first time.

Mr. G. H. HALLIGAN and Professor O. U. VONWILLER were appointed Scrutineers, and Mr. W. S. DUN deputed to preside at the Ballot Box.

The following gentlemen were duly elected ordinary members of the Society:—

IRWIN ORMSBY, Manufacturer, 'Caleula,' Allison Road, Randwick.

WILLIAM THOMAS WILLINGTON, Manufacturer, King Street, Arncliffe.

GEORGE WRIGHT, Director, Farmer and Company, c/o Farmer and Company, Sydney.

The Annual Financial Statement for the year ended 31st March, 1917, was submitted to members, and, on the

motion of the Honorary Treasurer, Dr. H. G. CHAPMAN, was unanimously adopted:—

GENERAL ACCOUNT.

RECEIPTS.	£ s. d.	£ s. d.
To Cash at Bank and on hand at 1st April, 1916		75 11 0
„ Subscriptions		509 5 0
„ Rents—		
Offices	288 10 0	
Hall and Library	108 5 6	
		396 15 6
„ Sundry Receipts		10 7 0
„ Government Subsidy for 1916 ...		399 19 8
„ Clarke Memorial Fund—		
Amount received to date ...		220 0 0
		£1611 18 2

PAYMENTS.	£ s. d.	£ s. d.
By Salaries and Wages—		
Office Salary and Accountancy Fees ...	157 17 6	
Assistant Librarian...	91 13 4	
Caretaker	126 1 0	
		375 11 10
„ Printing, Stationery, Advertising, Stamps, etc.—		
Stamps and Telegrams	35 9 3	
Office Sundries, Stationery, etc.	10 7 3	
Advertising	12 0 9	
Printing	57 19 0	
		115 16 3
„ Rates, Taxes and Services—		
Electric Light	20 13 10	
Gas	6 5 8	
Insurance	19 6 9	
Rates	105 5 0	
Telephone	8 0 10	
		159 12 1
„ Printing and Publishing Society's Volume—		
Printing, etc...	300 5 3	
Book-binding	20 6 3	
		320 11 6
„ Library—		
Books and Periodicals		106 3 9
„ Sundry Expenses—		
Bank Charges and Exchange	0 14 8	
Repairs	24 8 0	
Lantern Operator	9 15 0	
Sundries	27 0 5	
		61 18 1
Carried forward		1139 13 6

Payments—*continued.*	£ s. d.	£ s. d.
Brought forward		1139 13 6
By Interest—		
On Mortgage		115 0 0
,, Clarke Memorial Fund—		
Instalments to War Loan to date ...		220 0 0
,, Balance—		
Credit Balance, Union Bank of Australia Ltd.	98 2 0	
Less unpresented cheque	31 11 9	
	66 10 3	
Credit Balance at Savings Bank of N.S.W.	70 0 0	
On Hand	0 14 5	
		137 4 8
		£1611 18 2

Compiled from the books and accounts of the Royal Society of New South Wales and certified to be in accordance therewith.

HENRY G. CHAPMAN, M.D., *Honorary Treasurer.*

W. PERCIVAL MINELL, F.C.P.A.

Auditor.

SYDNEY, 21ST APRIL, 1917.

BUILDING AND INVESTMENT FUND.

Receipts.	£ s. d.
To Loan on Mortgage owing to the Australasian Association Advancement of Science—	
Balance as at 31st March, 1916	2300 0 0
,, General Fund—	
Amount received to date...	115 0 0
	£2415 0 0

Payments.	£ s. d.
By Interest—	
Amount paid to Australasian Association Advancement of Science	115 0 0
,, Balance owing at this date	2300 0 0
	£2415 0 0

CLARKE MEMORIAL FUND.

BALANCE SHEET, 31ST MARCH, 1917.

Liabilities.	£ s. d.	£ s. d.
Accumulation Fund—		
Balance as at 31st March, 1916		606 6 9

Liabilities—*continued.*	£ s. d.	£ s. d.
Brought forward		606 6 9
Additions during the year—		
Interest Savings Bank of N.S.W. ...	7 7 11	
„ Government Savings Bank ...	6 10 4	
„ Commonwealth Savings Bank	1 17 3	
„ War Loan	18 0 0	
		33 15 6
		£640 2 3

Assets.	£ s. d.	£ s. d.
Royal Society of New South Wales, General Fund		
Amount invested in Commonwealth War Loan		400 0 0
Cash deposited in Savings Bank of N.S.W. ...	151 14 2	
„ Government Savings Bank ...	48 12 7	
„ Commonwealth Savings Bank...	39 15 6	
		240 2 3
		£640 2 3

STATEMENT OF RECEIPTS AND PAYMENTS, 31ST MARCH, 1917.

Receipts.	£ s. d.	£ s. d.
To Balance 31st March, 1916—		
Savings Bank of N.S.W.	194 6 3	
Government Savings Bank	194 2 3	
Commonwealth Savings Bank	37 18 3	
		426 6 9
„ Interest to date—		
Savings Bank of N.S.W.	7 7 11	
Government Savings Bank	6 10 4	
Commonwealth Savings Bank	1 17 3	
War Loan	18 0 0	
		33 15 6
		£460 2 3

Payments.	£ s. d.	£ s. d.
By General Fund—		
Amount Invested in War Loan		220 0 0
„ Balance at this date—		
Savings Bank of N.S.W.	151 14 2	
Government Savings Bank	48 12 7	
Commonwealth Savings Bank	39 15 6	
		240 2 3
		£460 2 3

On the motion of Acting Professor L. A. COTTON, seconded by Mr. R. W. CHALLINOR, Mr. W. P. MINELL was elected Auditor for the current year.

A report on the state of the Society's property and the annual report of the Council were read as follows:—

ANNUAL REPORT OF THE COUNCIL FOR THE YEAR 1915-16. (1st May to 26th April).

The Council regrets to report that we have lost by death five ordinary members and one Honorary Member. Four members have resigned, and four names were removed from the roll owing to non-payment of subscriptions. On the other hand, thirty-one ordinary members have been elected during the year.

To day (25th April, 1917) the roll of members stands at 316.

During the Society's year there have been nine monthly meetings and ten Council meetings.

Two new Sections were established during the year, namely:—Section of Agriculture and Section of Industry.

On the 13th March an informal meeting of members took place to extend a welcome to Sir ERNEST SHACKLETON on his return from Antarctica.

Two Popular Science Lectures were given, namely:—

July 20—"*The Chemistry of Nitrogen and its Value for Food-stuffs and Explosives,*" by R. K. MURPHY, Dr. Ing., Chem. Eng.

August 17—"*The Debt of Agriculture to Science,*" by Prof. R. D. WATT, M.A., B.Sc.

Fourteen papers were read at the monthly meetings, and these, with a good number of exhibits, afforded much instruction and interest to members of the Society.

The President announced that the Council had awarded the Clarke Memorial Medal to Major (Professor) DAVID, C.M.G., F.R.S., of the Sydney University.

It was announced that the following members had died during the recess:—Dr. J. F. FLASHMAN, Mr. W. G. PYE, Dr. E. P. RAMSAY and the Rev. WILLIAM SCOTT.

The following donations were laid upon the table:—323 parts, 3 volumes, and 14 reports.

The President, Mr. T. H. HOUGHTON, then delivered his Presidential Address.

On the motion of Dr. ROSEBY a hearty vote of thanks was accorded to the retiring President for his valuable address.

Mr. T. H. HOUGHTON briefly acknowledged the compliment.

There being no other nominations, the President declared the following gentlemen to be Officers and Council for the coming year:—

President:

J. B. CLELAND, M.D., Ch.M.

Vice-Presidents:

HENRY G. SMITH, F.C.S.	R. GREIG-SMITH, D.Sc.
C. HEDLEY, F.L.S.	T. H. HOUGHTON, M. INST. C.E.

Hon. Treasurer:

H. G. CHAPMAN, M.D.

Hon. Secretaries:

R. H. CAMBAGE, L.S., F.L.S.	J. H. MAIDEN, I.S.O., F.R.S.

Members of Council:

C. ANDERSON, M.A., D.Sc.	J. NANGLE, F.R.A.S.
E. C. ANDREWS, B.A., F.G.S.	F. H. QUAIFE, M.A., M.D.
D. CARMENT, F.I.A., F.F.A.	C. A. SUSSMILCH, F.G.S.
W. S. DUN.	H. D. WALSH, B.A.I., M. INST. C.E.
Prof. C. E. FAWSITT, D.Sc., Ph.D.	Prof. W. H. WARREN, LL.D., Wh. Sc.

Mr. T. H. HOUGHTON, the out-going President, then installed Dr. J. B. CLELAND as President for the ensuing year, and the latter briefly returned thanks.

JUNE 6th 1917.

The three hundred and eighty-ninth General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth Street, at 8 p.m.

Dr. J. B. Cleland, President in the Chair.

Thirty-one members were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of nine candidates for admission as ordinary members were read: seven for the second, and two for the first time.

Mr. W. Welch and Mr. E. Cheel were appointed Scrutineers, and Dr. Greig-Smith deputed to preside at the Ballot Box.

The following gentlemen were duly elected ordinary members of the Society:—

Robert Henry Bond, Chief Brewer, Messrs. Toohey's Limited, 'Tiro-Tiro,' Middleton Street, Stanmore.

Ernest Breakwell, B.A., B.Sc., Government Agrostologist, Botanic Gardens, Sydney.

Frederick William Carpenter, M.A., Senior Science Master, Sydney Grammar School, College Street, Sydney.

Alfred Edward Hurse, A.M.I.C.E., Civil Engineer, 'Llanfair,' Robert Street, Strathfield.

William Poole, B.E., Assoc. M. Inst. C.E., M.I.M.M., L.S., Consulting Engineer, 906 Culwulla Chambers, Castlereagh Street, Sydney.

Samuel Edward Sibley, Chemist, 'Garnella,' Blenheim Street, Randwick.

Wilfred Joseph Spruson, Consulting Engineer and Patent Attorney, 91 Elizabeth Street, Sydney.

A letter was read from Mr. William Scott, in which he expressed thanks for the Society's sympathy in the death of his father, the late Rev. William Scott.

Six volumes, one hundred and fifty-six parts, one calendar and two reports were laid upon the table.

The President announced that certain scientific work on the measurement of earth-tides was being carried out by the Rev. E. F. PIGOT S.J., at Cobar, and invited members, who felt so disposed, to contribute towards the necessary expenses.

THE FOLLOWING PAPERS WERE READ:

1. "Notes on Acacia, No. 2," by J. H. MAIDEN, F.R.S.

2. "Table to facilitate the location of the Cubic Parabola," by C. J. MERFIELD, F.R.A.S. (Communicated by Mr. J. NANGLE).

EXHIBITS:

1. Dr. H. G. CHAPMAN exhibited a sample of "peptone" obtained from hen's egg-white. This had been prepared to replace Witte's peptone in media used for growing micro-organisms. Since the beginning of the war, bacteriologists had been husbanding their stocks of Witte's peptone, made in Germany, as other brands of commercial peptone on this market had not been satisfactory as substitutes for Witte's peptone. The "peptone" that he had made, was tested in a bouillon agar on which meningococci were sown. The meningococci grew luxuriantly, when this agar was stroked with serum. On subculture the meningococci grew on the peptone agar alone. Streptococci could be readily cultivated on media containing this "peptone." The "peptone" had been used with complete satisfaction in the Pathological Department of the University of Sydney for routine bacteriological investigations. Dr. CHAPMAN hoped that other bacteriologists would use it in preference to German peptone. The peptone had been prepared in the following manner:—One hundred and fifty cubic centimetres of fresh egg-white containing 15 gm. protein were stirred with 150 c.cm. 2% aqueous solution of sodium chloride. To this mixture 300 c.cm. N/10 soda were added. The alkaline liquid was warmed at 37° C. for 15 days in a sterilized flask when the fluid no longer coagulated upon boiling it. The

liquor was heated in a digester at 6 atmos. pressure for one hour. It became turbid and dark brown in colour. The precipitate which was not bulky, was removed by filtration and the liquid was heated in a steam sterilizer on three successive days. The brown solution of peptone contained 0·48% nitrogen corresponding to 3% peptone. The alkalinity to phenol-phthalein was such that 100 c.cm. solution required 4·0 c.cm. N/10 acid to abolish the pink colour of the indicator. The solution had been used to make the media.

2. Mr. R. T. BAKER exhibited a section of the North American Redwood *(Sequoia sempervirens)* taken from a tree grown at Reefton, New Zealand. It illustrates a rapidity of growth of secondary wood that is perhaps a world's record, the diameter of the tree measuring 2 feet $10\frac{1}{2}$ inches, at the age of 27 years; the width of each annual ring is about one inch.

3. Dr. J. B. CLELAND exhibited some beautiful coloured drawings, remarkable for their almost microscopic exactitude, of two Australian polyporoid fungi, kindly drawn by Mr. H. BUTLER of Derby, England, from specimens sent to him; also a series of watercolours of some of our larger soft fungi prepared by Miss PHYLLIS CLARKE.

JULY 4th, 1917.

The three hundred and ninetieth General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth Street, Sydney, at 8 p.m.

Dr. J. B. CLELAND, President, in the Chair.

Sixty members and four visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of four candidates for admission as ordinary members were read: two for the second, and two for the first time.

Acting Professor COTTON and Mr. R. W. CHALLINOR were appointed Scrutineers, and Mr. E. C. ANDREWS deputed to preside at the Ballot Box.

The following gentlemen were duly elected ordinary members of the Society:—

NORMAN CHARLES NASH, Analytical Chemist, 'Treleaven,' Darling Street, Balmain East.

DANSIE THOMAS SAWKINS, M.A., Trigonometrical Surveyor, 'Brymedura,' Kissing Point Road, Turramurra.

Mrs. J. F. FLASHMAN wrote thanking the Society for sympathy in her recent bereavement.

Two volumes, seventy-two parts, five reports and one calendar, were laid upon the table.

THE FOLLOWING PAPERS WERE READ:

1. "The Problem of the Great Australian Artesian Basin," by ALEXANDER L. DU TOIT, D.Sc., F.R.S.S., (communicated by J. E. CARNE).

Remarks were made by Acting Professor COTTON and Mr. ANDREWS.

2. "Sydney Water Supply," by T. W. KEELE, M. Inst. C.E.

On the motion of Mr. J. H. CARDEW, seconded by Mr. H. G. McKINNEY, it was decided to postpone the discussion on Mr. KEELE's paper until the Council had set apart an evening for the purpose.

EXHIBITS:

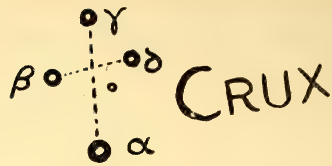
1. Rev. Dr. ROSEBY exhibited a chart of Southern Circumpolar Stars, and explained a simple method of finding the "South Pole" star, Sigma Octantis.

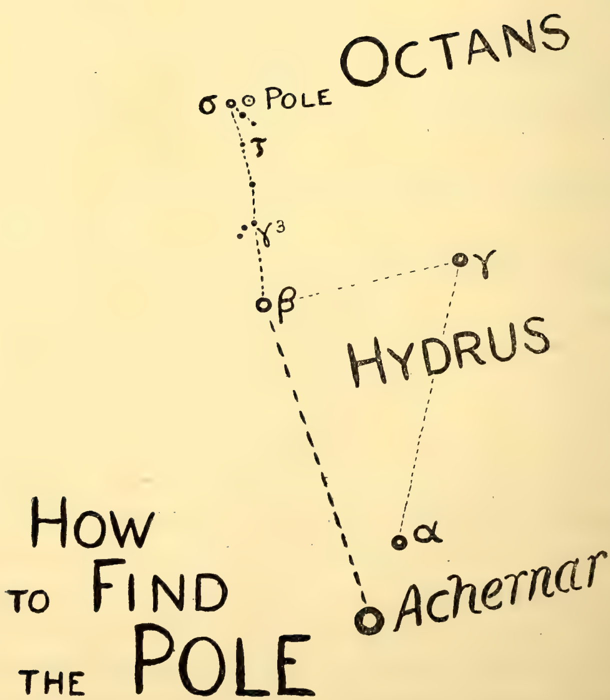
In exhibiting the New Southern Circumpolar Map issued by the N.S.W. Branch of the British Astronomical Association, Dr. ROSEBY remarked on the very few people who have ever seen the South Pole Star. Hardly one in ten thousand people in the

Northern Hemisphere has failed to see what is by pre-eminence called "the North Star," while hardly one in ten thousand here has ever seen the corresponding South Star. No wonder: it is barely visible to unassisted vision. Dr. Roseby then exhibited a diagram (a copy of which is shown herewith) which showed how the star might readily be found with any ordinary binocular glass. Starting with the best known southern constellation, the Southern Cross, you follow the line of its longer axis till on the opposite side of the pole you encounter Achernar, a brilliant first magnitude star. If you bisect this line between the uppermost star of the Cross and Achernar, you will be very near the South Pole, about 34° above the horizon in the latitude of Sydney. Now, starting from Achernar, and keeping throughout on the line towards the Cross, you meet the bright star, the brightest in the neighbourhood, β Hydri. And now, heading directly towards the Cross, you encounter the little triple asterism γ_3, thence an unnamed star, and then τ Octantis. The next star along this line is the pole star, σ Octantis, which you immediately recognise from two stars near it, B and omicron Octantis, making what looks like the acute bending of a "hoe." The pole star and B are nearly equidistant from the pole, and in 1922 will be exactly so.

The Circumpolar Map exhibited, which for a special reason, was confined to the area within two degrees of the pole showed about 180 stars. The ordinary star atlases, including that of Sydney Observatory, only show two or three stars within that area. But this limited region had recently occupied the observation and research of two great observatories—that of the Royal Observatory at the Cape, and that of the Columbia Observatory of the United States. The Cape Observatory catalogues 917 stars within the area, and the Columbia Observatory (Washington) 829. The map selects 180 of these, those within the range of ordinary telescopes. The map itself is a reproduction by Mr. E. R. Morris of an exquisite photograph by the Union Observatory of South Africa.

A unique feature of the Cape and Washington Catalogues is that the stars are numbered in a new, and much more accurate


γ
β
δ
CRUX
α


OCTANS
σ
POLE
τ
γ³
γ
β
HYDRUS
α
Achernar
HOW TO FIND THE POLE

order than is usual. The Ascensions of Stars so close to the pole became at length impossible of accurate measurement. The observatories named resorted, in consequence, to the method of rectangular co-ordinates, x and y, with the *origin* as the pole. Thus, where the ordinary method hopelessly breaks down, the places of the stars can yet be quite accurately fixed.

The effect of the *precession* of the *Equinoxes* is very strikingly shown on the map, which indicates the place of the pole in 1850 and in 1950, an interval of a hundred years. It will be seen how great a change of apparent movement among the stars must result from this perpetually changing centre.

The seven stars nearest to the pole, it was suggested as an aid to the memory, might be designated "the Septentriones." The word, so familiar to us in Cæsar's Commentaries is not necessarily hyperborean. The "seven plough-oxen" may without challenge be transferred to Antarctica.

It may be mentioned that the two catalogues, of which the local branch of the British Astronomical Association thus furnishes a map, are the result of a research which has a very important bearing on the interpretation of stellar photography—an exceedingly minute and difficult branch of present-day astronomical work—the inter-adjustment of overlapping plates being a study of the first importance in fixing with precision the places of the stars.

The map, it is hoped, may be an aid to accurate terrestrial survey. The number of stars thus for the first time rendered available cannot fail to be of service. The fixing exactly the place of the pole has not seldom been a matter of some perplexity.

2. Mr. A. J. SACH, F.C.S., exhibited some interesting samples of rubber from Malaysia, forwarded by Mr. COLIN P. THANE.

3. Mr. E. C. ANDREWS exhibited a fine specimen of molybdenite in quartz, from the Kitchener Lode, Khartoum, North Queensland.

AUGUST 1st., 1917.

The three hundred and ninety-first General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth Street, Sydney, at 8 p.m.

Dr. J. B. CLELAND, President, in the Chair.

Forty members and six visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of two candidates for admission as ordinary members were read for the second time.

Mr. A. D. OLLÉ and Mr. E. CHEEL were appointed Scrutineers, and Professor FAWSITT deputed to preside at the Ballot Box.

The following gentlemen were duly elected ordinary members of the Society:—

HERBERT TATE, Manufacturer, Bridge Road, Stanmore.

THOMAS IRWIN WALLAS, Bacteriologist, 175 Macquarie street, Sydney.

It was announced that the Engineering Association of New South Wales, tenants of this Society, had kindly placed their library at the disposal of members of the Royal Society, for reference purposes.

Five volumes, one hundred and fifty-nine parts, and nine reports were laid upon the table.

THE FOLLOWING PAPER WAS READ:

"On the Resin of the Outer Bark of *Melaleuca uncinata*," by H. G. SMITH, F.C.S.

The following discussion then took place upon Mr. KEELE'S paper, "The Sydney Water Supply":—

Mr. J. H. CARDEW, M. Inst. C.E., apologised for the absence of Mr. H. G. McKINNEY, who was prevented through illness

from being present, and he then spoke of the great necessity for an adequate supply of water in a city such as Sydney, and considered it was both safe and prudent to adopt as high as a 4% rate of population increase. He mentioned that the increase of manufacturing and the extension of the sewerage schemes in all the outlying suburbs of Sydney will largely increase the amount of water, and it is a matter of experience that the demand per head increases with the lapse of time, and the use of water always induces its use more lavishly, even for objects which are perfectly legitimate and which are not wasteful. The proximity of our sea beaches, and the facilities for sea bathing, no doubt to some extent, reduce our requirements. He thought that the consumption rate of 63 gallons per head, as proposed by Mr. KEELE for the year 1937, was too low, and that a rate of at least 80 gallons per head should be allowed, the consumption in the city of New York for the next 25 years being estimated at 150 gallons per head. He referred to the absence of available knowledge in regard to the topography, physical characteristics, contours, rainfall, the run-off of the catchment area, and the amount of water the catchment area can contribute, and said that the author has been obliged to adopt a run-off of 44%, but in all probability the higher parts of the catchment area will contribute a greater rainfall and greater rate of run-off than the author mentions. Under the circumstances it is impossible to make any estimate of the amount of water the catchment area can contribute, and the forecast made by the author must be to a very large extent guess-work, although in all probability it is a most conservative estimate that he has given us. The author bases his estimate of the yield of the catchment area on a 44% run-off, which compared with American catchments is very conservative. The Croton watershed in New York gives 48%; Sudbury 46·3%, National 47·3%, the Upper Hudson 57%, and the

Upper Mohawk 60%. It is a dangerous practice to rely on the comparative yields of other catchments whose physical characteristics would not bear comparison with the one we have under review.

Mr. CARDEW believed the higher parts of the Sydney catchment would give a larger rainfall and run-off than adopted by the author. It is surely necessary that a scientific exploration should be made of the whole of the Sydney catchment area embracing the question of rainfall, evaporation, porosity, volume of the streams, etc., to determine the amount of water the surface contributes to the rivers, and the amount of underground water contributed to the rivers, of the water table, of the soil, the chemical examination of the water, filters, observations of storage in the reservoirs, plan of reservoirs, bores, surveys with plans at ten feet intervals, a delineation of the various drainage areas on the catchment, geological survey, borings, and so on. Consideration of the foregoing seems to point to a higher percentage, as in the case of the Croton and Sudbury water sheds of the New York water supply, which amounts to about 50% of the rainfall. He mentioned with the proposed tunnel scheme, the fire stream would reach a height of 165 feet, which is greater than the City Council's building limit, and consequently no fire engine would be required. His computation showed that the tunnel from the Cataract to Bankstown would have to be 9 feet 2 inches in diameter, to give the necessary head to supply the branch tunnel from Bankstown, which would be 6 feet in diameter and carried to a point beyond Ryde, and would require a 24 inch main delivering $4\frac{1}{4}$ million gallons per day thence to the Wahroonga elevated tank, and at the same time to supply the outer branch. He estimated the cost of the main tunnel and branches to be £4,033,000; the cost of the whole scheme, embracing tunnels on the catchment with the

necessary resumptions being estimated at about £7,000,000. The estimate was based on the supposition that excavation would be carried out by compressed air drills and explosives, and would have concrete lining about 12 inches thick, but if the tunnels were excavated by machinery, probably no concrete lining would be necessary. If concrete lining could be eliminated, a saving of £1,250,000 would be made for that item alone.

The question of the porosity of the sandstone was discussed, and whether without concrete lining, it would allow the escape of water by percolation under a pressure of 800 feet. He quoted the Burraga Dam as an instance where the water, with a head of 60 feet, passed through the concrete to the outer face. By scrubbing cement into the face of the inner side of the dam, a perfectly smooth glass-like surface was given to the concrete, and the trouble entirely disappeared. He regarded Mr. KEELE'S scheme for the linking up of the dams by tunnels as a very excellent one, and the connecting of the head waters of the Wollondilly to Prospect, a far better and more practical scheme than what is known as the Warragamba scheme.

He considered Mr. KEELE'S proposition to be of such great value to the ratepayers of Sydney, that he urged the Society to bring the paper under the notice of the Government, so that the matter should be investigated. He concluded by moving:—

"That considering the national importance of Mr. KEELE'S paper, the Council of this Society should consider the question of personally waiting upon the Acting Premier, and asking for a Royal Commission of enquiry."

Mr. C. W. SMITH, M. Inst. C.E., (a visitor) considered the present source of water to be inadequate to meet the requirements of increasing population, and he regarded Mr. KEELE'S proposal as a most attractive one, and thought

there would be no engineering difficulty in undertaking the tunnel system.

Mr. CORIN, M. Inst. C.E., M.I.E.E., etc., (a visitor) raised the question as to the possibility of the pressure on the walls of the tunnel at the lower levels producing fissures through which the water might find its way to pervious strata at lower depth. He stated that he had been recently engaged on a scheme involving a tunnel between the Cataract and Cordeaux Reservoirs, for utilising the combined waters to produce electrical energy at a power station to be situated at Broughton's Pass, whereby an average of 16 million units could be supplied for pumping purposes in Sydney at a cost of 0·35d per unit. The use of these waters was not, however, essential for cheap power, and he anticipated in the future that, by developing the Shoalhaven River, and later the Snowy River, and by turning to account the energy now being wasted at the South Coast Coke Ovens, in ten years time electrical energy would be supplied in Sydney in bulk at from 0·2d to 0·25d per unit.

The figures in Mr. KEELE'S paper were based on sources of power largely uneconomical. By substituting the lower price of power for that mentioned by Mr. KEELE, the last figure in Column "Y" for the year 1947, would, instead of a surplus of £125,560 in favour of Mr. KEELE'S scheme, be a deficiency of £20,440, apart from the difference in the cost of the capital charges, Column "L," which would make the comparison still more in favour of electric pumping.

He brought forward this aspect of the question as deserving close inquiry when the question of the cost of Mr. KEELE'S scheme, versus pumping for future supply, might be under consideration. But he did not for a moment desire to detract from the value of Mr. KEELE'S proposals. On the contrary, even if pumping were proved to be cheaper, the advantages of the permanency of the work and its

security from interference, the absolute purity of the water and the pressure enabling fire-fighting to be carried on under the best conditions through the Metropolitan area, might be found to be well worth the additional cost.

Mr. E. STATHAM, M. Inst. C.E., considered the time was opportune for bringing forward this question of water supply. He mentioned that over fifty years ago, Mr. W. C. BENNETT, then Engineer for Roads and Bridges, had formed the opinion that the Cataract and Cordeaux watersheds was the best source for a gravitation supply for Sydney. He considered the present canal insufficient to keep the Prospect reservoir full. He favoured some use being made of the head waters of George's River, which was as worthy of consideration as the Cordeaux. A dam of moderate height would be sufficient to head up George's River to canal level, and it could be connected either by a cutting or a short length of tunnel, adding an appreciable amount of storage either for Prospect or the scheme proposed by Mr. KEELE.

Mr. J. M. SMAIL, M. Inst. C.E., remarked that in connection with water supply, Sydney had suffered from want of storage and want of money, and he considered that Mr. KEELE had done a public duty in drawing attention, especially to the want of storage.

Mr. W. POOLE, B.E., Assoc. M. Inst. C.E., said that it seemed to be assumed that the cross section of the proposed tunnel will be circular; as a matter of construction it would be much easier to make it rectangular with a supporting arch if necessary. The excavation would be easier carried out, both for the blasting and removal. The floor would probably not require any further protection, and the walls would probably need no more concrete than would be necessary to form a smooth surface for the run of the water. With respect to the question as to whether the rock would take

the pressure, he had made one calculation in the matter and at the deepest part the rock pressure is practically the same as the hydraulic pressure; therefore, any great strength of lining would he thought be quite unnecessary.

Mr. A. D. OLLÉ, F.C.S., seconded Mr. CARDEW's motion, which was carried. It was arranged that Mr. KEELE would be given an opportunity at a subsequent meeting to reply to the discussion.

EXHIBIT:

His Honour Judge DOCKER exhibited an interesting set of stereoscopic views prepared from photographs he had taken at the Cataract and Cordeaux Rivers.

SEPTEMBER 5th, 1917.

The three hundred and ninety-second General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth Street, Sydney, at 8 p.m.

Dr. J. B. CLELAND, President, in the Chair.

Thirty-one members and one visitor were present.

The minutes of the preceding meeting were read and confirmed.

The certificate of one candidate for admission as an ordinary member was read for the first time.

Six volumes, seventy parts and seven reports were laid upon the table.

The death was announced of Mr. EDMUND MILNE, who was elected a member of the Society in 1916.

The President announced that on the 20th September, Professor A. ANSTRUTHER LAWSON would deliver a popular science lecture on "Heredity and the Laws of Mendel."

Mr. J. B. HENSON, Assoc. M. Inst. C.E., then contributed to the discussion on Mr. KEELE's paper, "The Sydney Water Supply." He said :—A supplementary supply of water for

the industries which are gradually growing about Botany could, if found necessary in the future, be obtained from the catchment of George's River and its southern tributaries. This supply of second class water would take the place of the high class water for industrial purposes. The establishment of the water supply from the Upper Nepean catchment assisted in giving another impetus to the growth of the Metropolis, and Mr. KEELE has clearly shown how necessary it is that this catchment, together with some minor neighbouring catchments, should be exploited for water to its fullest extent, and that this work is extremely urgent. I cannot too strongly emphasise the importance of immediate action in the matter of a comprehensive investigation into the future requirements of the Metropolis, and the development of a scheme for making liberal provision for satisfying them.

In view of the difficulties and expense attending the supply of sufficient first class water to the Metropolitan area, the question arises whether it would not be expedient to consider the advisability of placing some limit on the expansion of the metropolis by encouraging decentralization. The water of the Wollondilly is not as pure as that from the Upper Nepean, and in Mr. KEELE'S scheme filtration is suggested. This raises the question, whether in the development of a scheme for amplifying the water supply, cheap water can be provided for industrial purposes and the first class water conserved—the quantity of which is limited—for domestic and similar requirements. This does not necessarily mean a double set of reticulation pipes throughout the Metropolis, but restricted only to the areas which are devoted mainly to industries requiring a large amount of cheap water—as in the Botany area previously referred to—and to areas which should be set apart for the location of factories.

Mr. KEELE then replied to the discussion. He said, I am pleased that Mr. CARDEW agrees with me that a 4% per annum cumulative increase in the population is not too great in view of all the circumstances. In all the forecasts which have previously been made, the rate of increase in the population has always been too low. For instance, the Royal Commission of 1902, estimated it at 2½%. Mr. L. A. B. WADE'S estimate in 1909, when reporting on the Warragamba scheme, was 3·6%. The extraordinary increase from that time to the present may be an abnormal one, but it must be given due weight, extending as it does over a period of seven years. Even if it should prove in the future that my estimate of 4% per annum is excessive, I think it wiser to be prepared for it than to adopt a lower rate.

With reference to the consumption of water per head of the population, Mr. CARDEW takes a strong exception to the figures I have chosen as being much too low, and he also considers that the rate should be progressive and not as I have shown. He thinks the amount of 63 gallons per head per day will be largely exceeded by 1937, and that the works should be designed for that capacity.

In reply to Mr. CARDEW, I would say that I quite agree with him in his argument, and were it reasonably possible to make this provision, I think it should certainly be done. We are, however, most unfortunately in this position, viz., that we must be content to "cut our coat according to our cloth." For at least seven years (indeed ten years would be nearer the truth) we have been resting on our oars, doing nothing to increase the storage, so that it will strain our resources to the utmost to construct the necessary works in the order I have shown during the next twenty years, and even these will barely provide the storage necessary to meet the demand for water, in addition to the

provision for reserve storage which I have advocated, assuming that the consumption per head per day, does not exceed the figures from year to year, as shown in my table of costs. The question of what should be sufficient average consumption per day is a very debateable one. It is quite true, as my friend Mr. CARDEW has stated, that at New York provision has been made for a consumption of 150 gallons per capita, per day (or rather 125 gallons according to the British standard). He might have gone further, for at Tacoma, Washington, the consumption is at a rate of 375 gallons per capita daily. At Buffalo, New York, population 450,000, consumption 258 gallons; Cincinatti, population 325,000, consumption 271 gallons; Pittsburg, population 321,000, consumption 208 gallons; Chicago, population 1,254,000, consumption 191 gallons per capita daily.

One reason for this lavish use no doubt is that water is sold at a very low rate for public supplies. It is also well known that waste accounts for much of it. There are instances on record of a saving of from 30 to 50% being made after proper investigation, by the institution of metering, and by the use of waste water detectors. It is largely owing to the very efficient manner in which a check has been made upon waste, that our own Water Board has been able to keep down the average daily rate of consumption per capita. This, together with the absolute necessity for economising which has so long been recognised here, is the reason why our rate is so low as it is.

Mr. CARDEW says that the increase of manufacturing will largely increase the amount of water used, and that the demand increases with the lapse of time. Concerning this matter, some very interesting information can be gained by referring to the Address of Sir JAMES MANSERGH to the Institution of Civil Engineers, on the 6th November, 1900, in which he stated that the consumption per capita daily

at Birmingham with 800,000 people was 24·56 gallons, of which 15·29 gallons were supplied for domestic purposes, and 9·27 gallons for trade and public purposes. At Manchester, with a population of 1,100,000 persons, the consumption per capita daily was 29·5 gallons, of which 16·5 gallons were supplied for domestic, and 13 gallons for trade purposes. At Liverpool, with 968,000 population, the consumption per capita daily was 31·17 gallons, of which 17·89 gallons were supplied for domestic and 13·28 gallons for trade purposes. At Glasgow, with a population of 1,000,000, the consumption per capita daily was 54 gallons, of which 34 gallons were for domestic and 20 gallons for trade purposes. At Dublin, with a population of 320,000, the consumption per capita daily was 36 gallons, of which 29 were for domestic and 7 for trade purposes. At Paris, with a population of 2,600,000, the consumption per capita daily was 46·86 gallons, of which 18·05 gallons were for domestic purposes and 30·81 for trade purposes. At London, with a population of 5,953,000, the consumption per capita daily was 35 gallons, of which 27 gallons were for domestic and 8 gallons for trade purposes.

As our population is close upon one million, we need hardly fear a great increase of water from prospective manufacturing industries, seeing that the consumption per capita daily on the list just quoted ranges from 7 gallons at Dublin, to 30·81 gallons at Paris for trade and public purposes, the average being under 12 gallons per head. With reference to the amount which should be sufficient for domestic purposes, the following quotation is from a report of a committee on water consumption, published in the Journal of the American Water Works Association, March 1915, after investigating the water supply services of about 260 towns in the United States :—

"Domestic use: Our results seem to indicate that the old standard of 100 gallons per capita, or even 50 gallons,

which has been much used by engineers of late, can now be replaced in most committees by an allowance of 25 gallons per capita daily for domestic use, and that half of this amount is a possibility where meters are in general use. But here tabulated statistics must not be applied without judgment, for obviously it is unjust to compare a mill town in Western Pennsylvania, having no lawns, few sewers, and where poverty or economy reigns, with a suburb of New York or Chicago, having wide lawns, thorough sewage, and the elaborate plumbing of prosperous homes."

The consumption per head per day of the British towns, for domestic purposes, only ranges from 15·29 gallons, at Birmingham, to 34 gallons at Glasgow, the average being 23·26 gallons, used to indicate that about 25 gallons is sufficient where meters are in use, and if to this be added say 20 for purely trade purposes, and 15 gallons for public purposes, it would bring the total up to 60 gallons per head per day for all purposes, which, under the proposal formulated by me, Sydney would have in 1925, 8 years hence, rising to 71 gallons per head in 1947, 30 years hence. I hope Mr. CARDEW, after this explanation, will admit that my estimate is not merely guesswork, and that it is a reasonable one under our present conditions.

Mr. CARDEW refers to my statement that I had to rely upon spot levels, on the catchment area, made by Mr. Surveyor LEE with an aneroid barometer, for the purpose of ascertaining whether the sites for dams upon the area could be connected by tunnelling. I was not aware that any further work had been done here until Mr. CORIN informed me at the last meeting that a very complete hydrographic survey of the whole catchment area has, during recent years, been carried out by the Works' Department.

There is no alternative for Sydney, but to look forward to its future water supply being provided from storage reservoirs, hence the necessity for jealously conserving every square mile of the present catchment area, and if possible making additions to it, as I have shown can be done at the north and south ends to the extent of 140 square miles, making a total of 490 square miles of clean gathering ground, from which it is possible to gravitate the water in the city, an inestimable boon, as will be discovered later when resort has to be made to the waters from less favoured country, when filtration will be necessary.

Mr. CARDEW criticises my proposal to convey the water from the Cataract Reservoir to Sydney through pressure tunnels, in which he differs from me in the size of the tunnels, the method of excavation and lining, and the total cost of the work. I do not wonder at it, for the computations are, as he also found, very complex and difficult. I may say, however, that I gave the whole matter a great deal of study, and am still of opinion that my results will ultimately be found to be not far out.

I may say that I recognised the loss of head which would result by connecting several small rising mains with the shafts at Ryde and Crown Street, and so made the branch tunnels large enough to convey the whole supply of 75 millions each to Wahroonga and Waverley respectively. If therefore, any difficulty should arise in the future, it would only be necessary to extend the tunnels to Wahroonga and Waverley, and convey the water up shafts at each place to reticulate the whole supply from there instead of from the lower levels at Ryde or Crown Street. This of course would add to the cost, but not materially. With reference to the question of excavating the tunnels, Mr. CARDEW said "Mr. KEELE'S estimate is based on the excavation

being carried out in the old-fashioned system, that is, by compressed air drills and explosives and concrete lining, but if the tunnels were excavated by machinery we should have a perfect tube in the sandstone of the exact diameter required, and supposing the rock to be free from fissures, which at that depth might reasonably be expected, the concrete lining could be eliminated, and a saving of one and a quarter million pounds for the concrete lining alone could be made without taking into account all the extra excavation saved." Mr. CARDEW proceeded to describe a tunnel boring machine that was used in the Bondi Sewer Tunnel which cut a perfectly true tube of smooth internal surface, and this machine he said was intended for use in the Channel Tunnel. "Owing to the incompetence of the men who worked it, there were continued stoppages, first one thing went wrong then another, and finally owing to the delay incurred, the contractor ordered it off the job, and the tunnel was excavated in the ordinary way."

Now this had been the experience everywhere in the history of tunnelling, so far as I have been able to ascertain. A similar machine was tried in the Nepean tunnel, with almost exactly similar results. In the very excellent description of the great work in connection with the New York water supply by Mr. PRELINI, in Volume xcvii., Engineering, the pressure tunnels were excavated in the ordinary way, and surely if mechanical science has devised a machine which would effect so great a saving as Mr. CARDEW estimates, it would have been used, or at least tried, in one of the most recent tunnels of considerable length, viz., the Long Bay Outfall Sewer; but such was not the case, the work being carried out in the old-fashioned way, viz., by compressed air drilling and the use of explosives.

Until a satisfactory machine has been invented to cut a perfect tube through the sandstone rock, I think it will be

admitted to be the wiser course to pursue, in estimating the cost of such works, to provide for the excavation being done by compressed air drilling and explosives, and filling the space between the diameter of the tunnel and the rock all round with concrete, in a similar manner to the work done recently at New York in their pressure tunnels. As it is some years now since they were completed, and brought into use, and we have not had any report of their being defective in any way, we cannot, I think, do better than profit by their experience.

The question of the resisting capacity of the Hawkesbury sandstone, to the water in the tunnel under the pressure it would be submitted to, due to the head at the Cataract Reservoir, even though the tunnel be lined, was dealt with both by Mr. Corin and Mr. Cardew in a very interesting way.

Mr. Corin was of opinion that the question whether such a pressure as 600lbs. per square inch could be resisted by concrete without reinforcement, even if backed up by the Hawkesbury Sandstone, under the considerable pressure of the superincumbent mass of rock, would have to receive careful consideration, supported, perhaps, by experiment.

Mr. Cardew said his experience was that at a depth of 150 feet below rock surface, as a minimum the rock is as compact as ordinary concrete, and except where fissures are met with concrete lining would be unnecessary in a tunnel excavated by machinery. He said the sandstone rock always contains a large percentage of water, and if there are not pits or cleavage planes at that depth, the hydraulic grade of the water table in the sandstone would be flat, so that the rock would not absorb much water from the tunnel under pressure, or if it did absorb any, it would soon become surcharged and cease to do so. He was of opinion that, if provision were made for a thickness of con-

crete to make the tunnel water tight, 7 inches would suffice.

I quite agree with these gentlemen that it will be absolutely necessary to make very careful inquiry into the capacity of the Hawkesbury Sandstone to resist the pressure it will be subjected to before adopting my proposal.

We know the Water Board of New York followed the plan of locating their pressure tunnels at a depth not less than 150 feet below the surface of the rock, the character of which, however, has not been stated. On an average the rock was found at about 50 feet below the ground surface, this giving an average depth of 200 feet. This depth was selected for the purpose of obtaining a thick, solid bed above the tunnel, well able to resist the hydrostatic pressure.

Great care was taken to test the rock when crossing the river Hudson. Many borings were made, and they showed that in the middle of the river rock occurred at a depth of not less than 800 feet. As many as 14 cross sections of the river gorge were taken, requiring about 300 borings, and it was ultimately decided to cross the Hudson at Stormking, where the river runs between two mountains. Subsequent investigations at this place resulted in the tunnel being located at a depth of 1100 feet below the surface of the river at L.W., the hydrostatic pressure in the tunnel being 750 square inches. Here the tunnel was lined with 17 inches of concrete, but elsewhere it was less, varying with the pressure, the least thickness being about 9 inches. Very little timber was used in the tunnel while the excavation was being carried on, the supports being of light steel trussing, which were allowed to remain, and were buried in the concrete, in which pipes were inserted at frequent intervals, and after allowing about three months for the concrete to harden, grouting

was forced through the pipes in order to fill any voids that might occur between the concrete and the rock.

The cost of these pressure tunnels, which were $14\frac{1}{2}$ feet in diameter, was on the average 180 dollars (£36 18s. 9d.) per 1 inch foot of completed tunnel. This price does not include the engineering, real estate, nor administrative expenses, which would increase the figures from 15 to 20%.

In estimating the cost of the work I propose, viz., for a main tunnel, 7 feet 8 inches diameter and 27·3 miles in length, branch tunnel to Crown-street, 5 feet 3 inches diameter and 11·55 miles in length, and a branch tunnel to Ryde 5 feet 11 inches diameter and 8·3 miles in length. I have provided for the works to be carried out under a similar system to that adopted in New York, and the cost works out as follows:—

	£	s.	d.	
Main Tunnel	16	9	7	per 1in. ft.
Branch Tunnel to Crown-street	12	17	7	,, ,, ,,
Branch Tunnel to Ryde	13	14	1	,, ,, ,,

These prices include the cost of shafts, and all other expenses, including engineering.

Mr. Corin supplied some very interesting information with reference to the comparative cost of pumping and of power supply in Sydney. He proposes to provide a power station at Broughton's Pass, by utilising the daily flow (and in times of flood the overflow) from Cataract Reservoir and the Cordeaux Reservoir, combined by means of a tunnel between them. Mr. Corin claims that the result of supplying electrical energy in the manner he proposes, would be that the pumping costs (column N) of my table in 1947, instead of being £641 per day would be only £239 per day, resulting in a saving of over £400 per day, £146,000 per annum, in which case, instead of the saving of £125,500 per annum in 1947, shown by the last figures

in column Y of my table, there would be a loss of £20,440 per annum, apart from the difference in capital charges (column L), which would make the comparison still more in favour of electric pumping.

This result arrived at by Mr. CORIN would be rather disconcerting if it could be seriously considered that an arrangement of power stations such as he describes, which would be liable to have its operations interfered with by industrial strikes (which appear to have come to stay), and also be subject to all the risks of interference that have already been referred to in my paper, as well as depending upon the daily flow to Sydney, which after passing through the turbines continues to wend its course along the existing canal, would be accepted by the citizens in preference to the other power station at Broughton's Pass, and to the steady, reliable, uniform and continuous service to be performed by the "pressure tunnels," thus enabling the present system of pumping to be discontinued, while the daily supply of water for the city is carried by an entirely independent conduit, located in such a manner as to safeguard the water from any possible interference of any kind whatsoever, whether by accident or design. I, therefore, think the question of supplying electrical energy for pumping purposes in the manner described by Mr. CORIN, should not be allowed to interfere with the requirements of high pressure water supply. The two schemes will never be found to work either economically or harmoniously together. "One cannot eat one's cake and have it." I notice that Mr. CORIN, in some remarks he has recently contributed, recognises the truth of this adage, for he says—"The use of Cataract and Cordeaux water at Broughton's Pass necessarily could not be considered if Mr. KEELE's scheme is carried out, as the head would be required for providing the whole of Sydney with high pressure water supply, and thus would not be available for power."

From Mr. STATHAM'S statement it is evident that to Mr. BENNETT belongs the credit of originating the idea for obtaining a water supply for Sydney from the Upper Nepean. But the difficulties in the way were very considerable, there were few maps obtainable, and the country south and west of Appin was quite unexplored, and little was known of it except from timber getters. The information supplied by Mr. STATHAM with reference to the possibility of storing a considerable amount of water at the head of George's River is well worthy of investigation.

I agree with Mr. POOLE that a circular tunnel would be rather inconvenient, and probably more costly to excavate than a rectangular one, to be subsequently arched and inverted. This is a matter for consideration when the design comes to be dealt with. I adopted the circular section merely for convenience in calculating the discharges of the various tunnels under review.

In conclusion, I would like to impress upon all concerned the necessity of dealing promptly with this question of improving the Water Supply of Sydney. An investigation such as was proposed by Mr. CARDEW, and approved of by the members of this Society, should be commenced without any further delay.

From my point of view, after a very close study of the rainfall question extending over many years, I am of opinion that we are in a period of declining rainfall, which commenced in 1894, and has continued to the present time with an occasional year above the average. We may have a very few years more above the average, but I feel certain that from 1921 to at least 1931 the decline will be more severe and continuous than anything we have yet experienced. We should therefore endeavour to be prepared for it.

THE FOLLOWING PAPER WAS READ:

"Notes on Acacia, No. 3, extra tropical Western Australia, (with a description of a new species)," by J. H. MAIDEN, I.S.O., F.R.S.

Dr. F. H. QUAIFE then showed lantern slides of a natural tree-graft on portions of a tree of *Angophora lanceolata*, growing at Killara, the main fusion of the two large limbs being about three feet three inches long.

Remarks were made by Mr. MAIDEN, His Honour Judge DOCKER, Mr. A. B. HECTOR and the President.

Dr. QUAIFE also showed lantern slides of miniature earth pillars, from one to four inches high, formed by rain on a sand-heap at Killara, the top of the pillars being protected by small pieces of ironstone. These resembled, on a small scale, the large pillars of 40 to 50 feet high in Colorado, U.S.A., referred to in the "Encyclopedia Britannica," 11th edition.

OCTOBER 3rd, 1917.

The three hundred and ninety-third General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth Street, at 8 p.m.

Dr. J. B. CLELAND, President, in the Chair.

Thirty-four members were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of three candidates for admission as ordinary members were read: one for the second and two for the first time.

Mrs. E. MILNE wrote thanking the Society for sympathy in her recent bereavement.

Forty-five parts, four reports and one map were laid upon the table.

THE FOLLOWING PAPERS WERE READ:

1. "Azurite Crystals from Mineral Hill, near Condobolin, N.S.W.," by C. ANDERSON, M.A., D.Sc.

2. "Notes on Topographical, Ecological and Taxonomic Ocean Shoreline Vegetation of the Port Jackson District," by A. A. HAMILTON.

Remarks were made by Mr. HALLIGAN and Mr. HEDLEY.

3. "Some Determinations of the Heat Conductivity of Selenium," by EDNA D. SAYCE, B.Sc. (Communicated by Acting Professor O. U. VONWILLER).

4. "Notes on the early Stages of Development of *Lysurus Gardneri (L. australiensis)*," by J. B. CLELAND, M.D., and EDWIN CHEEL.

5. "A fossil Isopod belonging to the Fresh-water genus *Phreatoicus*," by CHARLES CHILTON, M.A., D.Sc., F.L.S., etc. (Communicated by R. J. TILLYARD).

NOVEMBER 7th, 1917.

The three hundred and ninety-fourth General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth Street, at 8 p.m.

Dr. J. B. CLELAND, President, in the Chair.

Thirty-five members and one visitor were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of two candidates for admission as ordinary members were read for the second time.

Mr. A. D. OLLÉ and Mr. A. A. HAMILTON were appointed Scrutineers, and Mr. J. NANGLE deputed to preside at the Ballot Box.

The following gentlemen were duly elected ordinary members of the Society :—

AUGUSTUS WILLIAM GALBRAITH, Civil Engineer, Cockatoo Island, Sydney.

RICHARD FORD JENKINS, Engineer for Boring, Irrigation Commission, 6 Union Street, Mosman.

ARCHIBALD LANG MCLEAN, Doctor of Medicine, 'Gartfern,' North Road, Abbotsford.

The President announced the death of Mr. W. A. DIXON, F.C.S., and of Mr. S. L. BENSUSAN (in England) a former member of this Society.

It was also announced that Dr. F. GUY GRIFFITHS had gone on Active Service, and that Dr. T. FIASCHI had returned from the front.

One hundred and seventy parts, four volumes, five reports and one calendar were laid upon the table.

An interesting lecturette was delivered by Judge E. B. DOCKER, M.A., on "Some Rocks of Scientific Interest," illustrated by lantern slides. The subject included examples of the following:—"Weathering of protected Rocks and Clays," "Rocks carved by Waves," "Nature's imitative Sculptures," "Weathering of Trachytes," "Weathering of Granites and Basaltic Columns."

THE FOLLOWING PAPERS WERE READ:

1. "Acacia Seedlings, Part III.," by R. H. CAMBAGE, F.L.S.
2. "On some New South Wales Ironbarks," by R. T. BAKER, F.L.S.

Remarks were made by Mr. J. H. MAIDEN and Mr. E. CHEEL.

3. "Description of two Bora Grounds of the Kamilaroi Tribe," by R. H. MATHEWS, L.S.

Remarks were made by Judge DOCKER.

4. "Note on the Great Australian Artesian Basin," by E. F. PITTMAN, A.R.S.M.

EXHIBIT.

Mr. A. J. SACH exhibited an original specimen of auriferous quartz from Mount Morgan, and handed in an interesting account of the early history of this famous Queensland mine.

DECEMBER 5TH, 1917.

The three hundred and ninety-fifth General Monthly Meeting of the Royal Society of New South Wales was held at the Society's House, 5 Elizabeth Street, at 8 p.m.

Dr. J. B. CLELAND, President, in the Chair.

Thirty-eight members and four visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificate of CLYDE DOUGLAS GILLIES, M.Sc. Assistant Lecturer in Biology, The University, Brisbane, was read for the first time.

The President announced that Professor R. THRELFALL, F.R.S., a former President and Vice-President of this Society, had received the honor of knighthood, having been created a Knight of the British Empire.

Ninety-one parts, two reports and one calendar were laid upon the table.

THE FOLLOWING PAPERS WERE READ:

1. "On the Occurrence of Crystals in some Australian Timbers," by R. T. BAKER, F.L.S.

Remarks were made by Mr. R. W. CHALLINOR.

2. "Notes on Eucalyptus (with a description of a new species), No. IV.," by J. H. MAIDEN, F.R.S.

Remarks were made by Messrs. A. B. HECTOR, A. A. HAMILTON and R. T. BAKER.

3. "Cineol as a solvent in Cryoscopy," by C. E. FAWSITT and CHRISTIAN FISCHER.

4. "Notes on Australian Fungi, No. IV." by J. B. CLELAND, M.D., Ch.M., and EDWIN CHEEL.

5. "A novel application of Bromine Water in synthetic Organic Chemistry," by J. READ, M.A., Ph.D., and MARGARET MARY WILLIAMS, B.Sc.

Remarks were made by Mr. H. G. SMITH.

EXHIBIT.

Crystals in situ under the microscope, also lantern slides, by R. T. BAKER, F.L.S.

GEOLOGICAL SECTION.

ABSTRACT

OF

PROCEEDINGS OF THE GEOLOGICAL SECTION.

Monthly Meeting, 7th May, 1917.

Mr. J. E. CARNE, in the Chair.

Eight members were present.

Mr. J. E. CARNE and Mr. W. S. DUN, were proposed and elected as Chairman and Honorary Secretary respectively.

EXHIBITS:

1. Mr. J. E. CARNE exhibited molybdenite from Yetholme.

2. From the Mining Museum:—(*a*) Phosphate rock from the Wellington Caves. (*b*) Section of the Southern end of the Bulli Seam at Wongawilli. (*c*) Chabazite from Emmaville. (*d*) Stibnite from Taylor's Arm. (*e*) Spar from Belubula. (*f*) Molybdenite from Flinders Island.

3. Mr. E. C. ANDREWS exhibited Wollastonite from Yetholme, and Devonian quartzites with *Rhynchonella pleurodon.* Among the exhibits were some fine examples of contact metamorphism from Yetholme. These consisted of radiating masses of wollastonite with pyroxene and granular garnet, and nodules of wollastonite with nuclei of granular calcite in beds of altered volcanic ash and claystone. He exhibited also a large block of Upper Devonian quartzite, containing *Spirifer disjuncta* and *Rhynchonella pleurodon*, obtained from the sediments enclosing the contact minerals mentioned above. The latter appear to have been formed by the action of vapours, derived from an intrusive granite, on the Devonian sediments. (*b*) Molybdenite and garnet from Whipstick. (*c*) Molybdenite from

Cooper's Mine, Bolivia. (*d*) Molybdenite in garnet rock, Attunga.

4. Dr. C. ANDERSON, exhibited (*a*) Chabazite, twinned rhombohedra, 6 miles west of Emmaville. (*b*) Zinc blende, Baker's Mine. (*c*) Obsidianite, Stannifer. (*d*) Opals from Mount Stuart, Central Australia.

5. Mr. SIMPSON, exhibited (*a*) Fluor apatite wood from Dunalkyn, W.A. (*b*) Titaniferous limerock, Yallingup Caves, Western Australia.

6. Acting Professor COTTON exhibited calcite crystals, Excelsior.

7. W. S. DUN exhibited (*a*) Fasciculate *Cyathophyllum* from Taree, Carboniferous. (*b*) Collection of opalised shells from Stuart Range, of Cretaceous Age.

Monthly Meeting, 11th July, 1917.

Mr. J. E. CARNE, in the Chair.

Eleven members and six visitors were present.

EXHIBITS:

1. Messrs. J. E. CARNE and E. C. ANDREWS exhibited (*a*) Molybdenite in white quartz from the Kitchener Mine, Khartoum, 11 miles from Almaden, North Queensland, presented to the Mining Museum by Messrs. LAURENCE and LAURENCE; also photographs illustrating the mine workings and treatment plant. (*b*) Zinc blende with fine crystalline contours from Baker's Mine, Deepwater. (*c*) Examples of elvans carrying scheelite from Kootingal, three and a half miles from the railway. (*d*) Specimens of sphene-hornblende granite.

2. From the Mining and Geological Museum, (*a*) Amethyst quartz from the South Coast. (*b*) Quartz crystals with secondary hair-like growths of quartz from Dutchman's Lode, Torrington. (*c*) Stibnite from Burragine Mine,

Taylor's Arm, presented by Mr. D. H. MATTHEWS. (*d*) Crystallised molybdenite from Cooper's Pipe, seven miles S.E. of Bolivia. (*e*) Pyrites showing perlitic tracery.

3. Mr. C. A. SUSSMILCH exhibited a series of intrusive tuffs from the Devonian of Copeland.

4. Acting Professor COTTON exhibited (*a*) Photographs of aboriginal carvings at Kuringai Chase. (*b*) Specimens of *Encrinurus* from the Silurian of Lewis Ponds; the sediments containing the specimens have been much affected by stresses.

5. Dr. C. ANDERSON exhibited specimens of crystallised calcite from the Belubula Caves.

6. Mr. W. R. BROWNE exhibited (*a*) *Glossopteris* and *Gangamopteris*, the Newcastle Coal Measures, Pokolbin. (*b*) Series of fossils from Gosforth. (*c*) Notes on the succession of sediments in the Hudson Peak district. A discussion followed.

Monthly Meeting, 11th September, 1917.

Mr. J. E. CARNE in the Chair.

Eight members were present.

EXHIBITS:

1. From the Mining and Geological Museum, (*a*) Opalised belemnites from Stuart Range, and potch opal. (*b*) Gold-bearing andesite from Oparara, New Zealand, and pyritised marine Miocene fossils from the same locality.

Mr. C. A. SUSSMILCH gave some notes on the geology of the Seaham district. A discussion followed.

Monthly Meeting, 11th October, 1917.

Mr. J. E. CARNE in the Chair.

Nine members were present.

EXHIBITS:

1. Mr. W. R. Browne exhibited sections of schist from Victor Harbour, S.A.

2. Mr. W. S. Dun exhibited specimens of Actinocrinoids from the Silurian of Wellington, collected by A. Mathieson.

3. Dr. C. Anderson exhibited (*a*) Concretionary chromite, Barraba. (*b*) Chromiferous film on chromite, Barraba. (*c*) Colourless fluorite, the Gulf. (*d*) Scheelite including felspar, Kootingal. (*e*) Colourless sapphire rendered pale pink by radium action (Watkin Brown).

SECTION OF INDUSTRY.

ABSTRACT OF THE PROCEEDINGS

OF THE

SECTION OF INDUSTRY.

March 12th, 1917.

Mr. LOXLEY MEGGITT in the Chair.

Mr. T. L. G. LAW, of Messrs. PEARSON, LAW and Co., Melbourne, read an instructive paper upon Industrial Efficiency. A comprehensive report will be found in the "Australian Manufacturer," for March 24th, 1917. The writer showed that lack of efficient management was at the root of the continual trouble between employer and employee, and, if the co-operation of the worker was desired, more good feeling between the two would be necessary. Improvement of methods must start from the management, and when, as a result, the output is increased, the worker should benefit. Strikes generally start in badly managed establishments, where force is used instead of knowledge. The only way to ensure permanent industrial peace is to investigate every trade scientifically, and find out how much work can be done by the average man without injury to health. Then the wages and conditions which will induce him to do a full day's work should be determined and adopted. It is necessary to offer inducements to bring out the worker's best constructive ability. Costing systems are essential to discover where waste is occurring. Mr. LAW proceeded to explain the methods he had successfully adopted in his factory, by which he had increased the average output per man, the wages of the workers, and the profits of the firm.

The discussion was participated in by Messrs. BRACH, THOS. POOLE, CHURCHILL TUCKER, J. HENDERSON, A. B. HECTOR, the Chairman, and Dr. GREIG-SMITH, the Hon. Sec.

May 14th, 1917.

Mr. LOXLEY MEGGITT in the Chair.

A letter was read from the Hon. Secretaries of the Society announcing that a resolution had been passed by the Council and forwarded to the Warden of the University. It ran as follows:—"In view of the great importance of the fundamental sciences of Physics and Chemistry, the Royal Society asks that, in the matriculation examinations, special encouragement may be given by the Senate of the University to students to take up the study of these subjects, and also suggests that, if possible, an entrance scholarship be granted for science at matriculation."

Mr. W. T. WILLINGTON was nominated as chairman of the Section for the coming year, and was unanimously elected. It was proposed that Dr. GREIG-SMITH be Hon. Sec. He was duly elected.

A discussion upon Industrial Efficiency was opened by Mr. JAMES HENDERSON and contributed to by Messrs. WALLACE NELSON, THOS. POOLE, A. E. STEPHEN, JAMES NANGLE, S. H. SMITH, G. L. HUDSON, EDWARD STEDMAN, JAMES STEDMAN, A. B. HECTOR. Dr. R. K. MURPHY, the Chairman and Hon. Secretary.

It was decided to form a committee to consider the future conduct of the Section, the committee to report to the Section. The following gentlemen were duly proposed, seconded, and elected as members of this special committee:—Messrs. LOXLEY MEGGITT, J. NANGLE, S. H. SMITH, A. B. HECTOR, S. E. SIBLEY, R. T. BAKER, Dr. R. K. MURPHY with the Chairman and Hon. Secretary.

June 11th, 1917.

Mr. W. T. WILLINGTON, Chairman, in the Chair.

Prof. C. E. FAWSITT gave a lecture upon "Pure Foods," illustrated by means of lantern slides.

The lecturer pointed out the necessity for a Pure Foods Act, and discussed the working of the Pure Food and Drugs Act (1908) of New South Wales. It was pointed out that difficulties were met with in framing the regulations dealing with certain foods and drugs. The reference in a regulation to substances with which a food or drug shall not be adulterated, is apt to suggest to some minds ways and means for adulteration which might otherwise have never been thought of.

Sometimes a food or drug is purchased mainly on account of one particular compound (*e.g.* vanilla for its vanillin content). It may then appear advisable to stipulate by regulation what the percentage of the principal ingredient (only) shall be. When this is done, it may be possible for an unscrupulous man to use an inferior product, but make the percentage of the principal constituent come up to the required amount by addition of an artificially prepared (synthetic) compound. This is not permitted, but there is a difficulty for the analyst, in most of such cases, in showing any difference between the compound of natural origin and the compound prepared synthetically.

There are probably good grounds for refusing to permit the addition of these synthetic substances, for there is a possibility that some of the minor substances, although not specified as to amount (or even by name) are of importance in some cases, and that there is a certain balance between the chief constituent and the minor constituents in the good natural article which renders it more beneficial, when used as a food or drug, than a poorer natural article fortified by the addition of an important constituent.

The addition of certain preservatives, in limited amounts, to certain foods is permitted by the regulations, and this permission is justified by results. The general principle must be adhered to that the amount of preservative added shall, even if repeatedly introduced with the food into the human body, be without apparent bad effects. Further, addition of preservative should not be permitted where its presence is not absolutely necessary. It is possible in some cases, that addition of a preservative is resorted to not only to preserve good food, but with the intention of making altered and decomposed food more palatable. This possibility makes one hesitate about allowing the use of such "preservatives" at all.

Permission to use colouring matter in certain foods is granted, provided the colouring matters have been proved to be harmless, and provided they are not to be used so as to deceive or mislead the purchaser as to the quality of the article purchased.

The Special Committee appointed to consider the future conduct of the Section reported as follows:—"That the future work of the Section will have to be confined to educational work upon the following lines:—

(*a*) To urge publication of brief but pointed guides of what is being done in this State to provide education, both general and technical.

(*b*) The preparation and reading by members and others, also publication, of papers relating to applied science in industrial operations, to co-operation and efficiency systems.

(*c*) Arrangement of lectures and demonstrations on all matters relating to applied science."

It was proposed by Mr. A. D. OLLÉ and seconded by Mr. G. I. HUDSON, "that the special committee be appointed a

general committee for the remainder of the year." This was agreed to.

July 9th, 1917.

Mr. W. T. Willington in the Chair.

The Chairman intimated that gentlemen who were not members of the Society could obtain from the Hon. Sec., sectional cards at 10/6, which would enable them to vote in the Section.

Mr. Thos. Poole read a paper upon "Efficiency Methods and Scientific Management in Practice."

After explaining the necessity for a greater productivity in our industries, the writer proceeded to describe several improvements he had effected in the clerical department over which he had control. These brought about a considerable saving of time, and were accomplished with the co-operation of the employees. Other efficiency methods were described.

A discussion was entered into by Messrs. Wallace Nelson, A. B. Hector, Ennever and the Chairman.

September 10th, 1917.

Mr. W. T. Willington in the Chair.

Mr. Loxley Meggitt read a paper upon "The Treatment of the Byproducts of the Meat Industry," in which he described the processes by which the residual matters of the meat industry were utilised. These included every thing except butcher's meat, sheep skins, and cattle hides. He mentioned the treatment of clean bones, sinews, oleo oils, neatsfoot oil, horn, gelatine and glue, but dealt specially with the production of tallow and fertiliser.

Questions were asked by Dr. Murphy, Mr. A. B. Hector, the Chairman and Hon. Sec.

October 8th, 1917.

Mr. W. T. Willington in the Chair.

Dr. H. G. Chapman gave a lecture upon "The Cold Transport of Milk and the Preservation of Infants' Lives." This was illustrated by exhibits, experiments and lantern slides.

After demonstrating the substances in a pint of cow's milk, the lecturer proceeded to consider the changes which they might undergo through the activity of bacteria. The acid curdling and the sweet curdling were thus dealt with, and this led to the consideration of the dirt contained in it. By means of cultures on gelatine plates, Dr. Chapman showed the relative number of bacteria found in Sydney milk when brought from the country, and when supplied by suburban dairymen. The immensely greater number in country milk caused the lecturer to emphasise the need for cooling country milk previous to its long journey to the city. He concluded, by showing, from mortality tables that the chief cause of the deaths of infants between the ages of 3 and 6 months was from diseases of the alimentary tract, which are generally brought about by bad milk. The milk of the city companies should be continually examined by a competent bacteriologist.

A discussion was contributed by Drs. Cleland and Wardlaw, Messrs. L. Meggitt, A. D. Ollé, A. E. Stephen, S. E. Sibley, G. I. Hudson, Irwin Ormsby, the Chairman and the Hon. Sec.

November 12th 1917.

Mr. W. T. Willington in the Chair.

Mr. A. B. Hector gave an address upon "Brains and Business," in which he briefly described the general structure of the human body, tracing the relation between the digestive, the nervous systems, the various senses and the

brain. Business aptitude is largely a matter of educating various senses, so as to make the brain more alert in noting fine differences, not only in material things, but also in, what might be called the psychological aspect, in studying the traits and characteristics of mankind. The special training of the senses becomes of paramount importance in special businesses, such as the sense of touch to the cloth merchant, the sense of taste to the tea taster, the sense of smell to the perfumer, etc.

The main point that the lecturer desired to bring forth, was the fact that in our physical body, we had ideal structures which could be utilised for giving a new point of view to the inventive mind—*e.g.*, a student of wireless telegraphy would do well to study the structure of the ear. A student of telephony would do well to study the arrangement of the nerves in seeking for economical means of wiring his instruments, and an ardent student of engineering would do well to study the whole body for economical means of converting energy into work, and the business man, seeking for better means of organisation and development of his business, could hardly do better than study the organisation of the human body, with its marvellous system of checks and counter checks in the inhibitory system. He also emphasised that there was no better training for the business man than an intelligent study of some of the leading sciences, as after all business, like science, was but organised common sense.

Messrs. A. D. OLLÉ, A. TURNBULL and the Hon. Secretary, joined in the discussion.

December 10th, 1017.

Mr. W. T. WILLINGTON in the Chair.

Dr. GEORGE HARKER gave a lecture upon "The Right Way to Burn Coal," with lantern illustrations. An exten-

sive report of the lecture will be found in the "Australasian Manufacturer," for January 19th, 1918.

After referring to the work of the late Mr. T. U. WALTON in the direction of studying the economy of fuel utilisation, the lecturer proceeded to show that coal had been derived from the cellulose and resins of former plants. The proportions of the remains of these conferred certain properties upon the coal for the production of gas or of heat. When used as fuel, coal should be sold upon its calorific value as determined by a simple apparatus, such as Thomson's bomb. Coal is one of the few substances that a manufacturer buys without a guarantee as to its value.

The energy obtained from coal is but a fraction of the theoretical amount; the ordinary steam engine utilises 1/11 while the gas engine uses 1/5 of the energy of the fuel. Possibly the cheapest source of power now available is Mond producer gas, which is derived from bituminous and low grade coals.

Economy in the use of coal can only be secured by instituting a strict chemical control over the combustion. A pound of coal requires 12 pounds of air for its complete combustion, and while an excess of air is unavoidable, the excess should be kept as low as possible. This can be done by testing the composition of the chimney gases, for which cheap, simple and reliable carbon dioxide recorders are available. These give a continuous record of the carbon dioxide in the gases, and tell if the coal is being burnt to the best advantage. The use of coal dust as a fuel, as well as the surface combustion of gaseous fuel, was explained at some length.

A discussion was contributed by Drs. GUTHRIE and MURPHY, Messrs. F. W. STEEL, B. J. SMART, VICARS, A. B. HECTOR, S. E. SIBLEY and the Chairman.

SECTION OF AGRICULTURE.

ABSTRACT OF THE PROCEEDINGS

OF THE

SECTION OF AGRICULTURE.

First Meeting, May 7th, 1917.

Dr. J. B. CLELAND, President of the Society, in the Chair.

In reply to representations made, the Under Secretary for Agriculture wrote that farmers were not inclined to cultivate Barleys extensively, but that the Department was doing all it could to encourage its extended growth.

The Under Secretary for Agriculture also wrote in reply that the Government had decided to guarantee a first payment of 3/- per bushel for 1917 wheat at country stations, and a further advance to 4/- per bushel f.o.b.

Mr. H. W. POTTS, Principal of Hawkesbury Agricultural College, was elected Chairman of the Section.

PAPERS READ.

1. Dr. JOHN MARDEN read a paper with regard to the lack of potash fertilisers in Australia since the European supplies were cut off. Several likely Australian sources of potash were referred to. Dr. MARDEN, Mr. A. E. STEPHEN and the Hon. Sec. were appointed a sub-committee to consider the question.

2. Mr. W. W. FROGGATT gave a descriptive and lucid lecturette on the Sheep Fly Pest, which had accounted for the death of millions of sheep during the past year. He traced the pest to the evolution of a long and wrinkled wool type of sheep which harboured the parasite. He advocated poisoned baits as the most efficient means of eradication.

Second Meeting, June 5th, 1917.

Mr. H. W. POTTS, Chairman, in the Chair.

PAPER READ:

Mr. A. E. STEPHEN read a very comprehensive paper upon the various sources of potash available in Australia. He discussed the use of the mineral silicates and alunites, the possibility of potash deposits being found in the neighbourhood of certain saline lakes in South Australia; the kelp industry at Southport, Tasmania, and the potash obtainable as by-products in the sugar, wool-scouring and cement industries.

EXHIBITS:

Mr. E. CHEEL, exhibited tubers of *Solanum Commersoni* and *S. maglia*, both of which are said to be blight-immune potatoes.

Third Meeting, July 3rd, 1917.

Mr. F. B. GUTHRIE in the Chair.

Mr. S. T. D. SYMONS wrote that the matter of introducing legislation to deal with the sheep-fly pest was receiving consideration.

Mr. G. LIGHTFOOT, Acting Secretary of the Advisory Council of Science and Industry, wrote that a Special Committee was investigating the production of potassium sulphate from alunite.

Mr. E. BREAKWELL and Mr. G. WRIGHT were appointed Hon. Secs. of the Section in succession to Dr. GREIG-SMITH, to whom a hearty vote of thanks was accorded.

Mr. F. B. GUTHRIE, Dr. GREIG-SMITH, Mr. DARNELL SMITH, Mr. E. CHEEL, and Mr. A. E. STEPHEN, were appointed members of the Committee.

EXHIBITS:

Mr. A. A. HAMILTON exhibited the Sensitive Plant, *Mimosa pudica*, and suggested utilising its leguminous properties as a soil renovator.

Mr. E. CHEEL exhibited four different varieties of *Canavalias*, and suggested that the common coastal form *C. obtusifolia* might be used as a green manure and also as food for animals.

Fourth Meeting, September 11th, 1917.

Mr. H. W. POTTS in the Chair.

PAPERS:

1. Professor R. D. WATT delivered a lecture on the Rothamsted Experiment Station and its work; the valuable work that this Station has done and is still doing was graphically illustrated. Amongst the principal points emphasised were (1) the effects of complete mineral manures added to nitrogenous fertilisers, as against mineral manures alone, (2) the value of different rotations including clovers, and (3) the value of nitrogenous fertilisers on pastures in increasing both the bulk and variety of the grasses.

2. Mr. E. N. WARD, Superintendent, Botanic Gardens, addressed the meeting on General Horticulture. Mr. WARD traced the development of horticulture from the Louis XIV or Versailles period to the present day. He entered a plea for a scientific stimulation of this important branch of agricultural science. Much could be done by the establishment of a School of Horticulture.

Fifth Meeting, October 9th, 1917.

Mr. H. W. POTTS in the Chair.

A discussion took place on the paper on General Horticulture, read at the previous meeting. A sub-committee consisting of the Hon. Secs., Messrs. WARD, CHEEL, STEPHEN and HAMILTON was appointed to investigate the best means by which horticulture could be stimulated.

PAPERS.

Dr. PETRIE read a paper on "Our present knowledge of hydrocyanic acid in plants." The lecturer illustrated by sketches the synthesis and breaking down of the various glucosides in certain plants. The amygdalin compound as the warm foundation for most glucosides, was clearly described. The action of oils, ferments, enzymes and proteids on glucosides, and the manner in which hydrocyanic acid may be liberated, were explained. The economic importance attached to the subject was emphasised.

EXHIBITS:

Mr. DALTON exhibited a Fly-trap, and also records by Mr. NEWMAN, Entomologist of West Australia, illustrating the efficient manner in which the fruit fly can be detected by means of this trap.

Mr. A. A. HAMILTON exhibited a specimen of the bitter water melon *(Citrullus vulgaris)* from Wilcannia, pointing out that owing to its hardy nature, it may prove a useful fodder plant in the interior.

Sixth Meeting, November 13th, 1917.

Dr. CLELAND, President of Royal Society in the Chair.

An expression of sympathy for Mr. F. B. GUTHRIE in the death of his son was passed.

PAPERS:

Mr. E. CHEEL read a paper on oil-yielding plants. The chemistry of the vegetable oils was dealt with. The economic importance attached to the oils which are used in food industries and for many technical purposes as soap and candle making, fuel etc., was pointed out. The following oils were emphasized as being worthy of exploitation in Australia:—Pea-nut oil, Soy-bean oil, Cotton-seed oil and Olive oil.

Seventh Meeting, December 11th, 1917.

Mr. H. W. POTTS in the Chair.

PAPERS:

Mr. H. W. POTTS, Chairman of the Section, delivered a lecture on Agricultural Education in America. The lecture was illustrated with a particularly fine series of lantern slides depicting the wonderful development of the technical arts and agricultural science in America. Particular emphasis was laid on the handsome manner in which agricultural science is endowed in the States. Mr. POTTS stated that agriculture and the teachers of agriculture were almost worshipped in America.

Mr. POTTS stated that he returned to Australia after a tour of the globe, convinced that here we have the richest agricultural country in the world. The pity of it is that up to date we have not risen to our opportunities.

EXHIBITS:

Mr. E. CHEEL exhibited three distinct kinds of beans recently introduced, viz., (1) Kratok Bean, an evergreen creeping fodder plant; (2) Rabaul Bean, similar to Kratok but splashed with reddish marks; (3) a bean *(Phaseolus vulgaris)* from a German ship captured by the Portuguese.

Three excursions were held during the year, viz., Hawkesbury Agricultural College (twice), and Grantham Stud Poultry Farm.

SECTION OF PUBLIC HEALTH AND KINDRED SCIENCES.

ABSTRACT OF PROCEEDINGS

OF THE

SECTION OF PUBLIC HEALTH AND KINDRED SCIENCES.

Abstract of the work of the Section for the year 1917, the third year of its existence.

The work of this Section was very much curtailed this year owing to the fact that the Honorary Secretary, Dr. GUY GRIFFITHS, left on active service in August, and no member was immediately available to take up his duties.

The following office-bearers were elected for 1917 :—

Chairman—Dr. CECIL PURSER.

Hon. Secretary—Dr. GUY GRIFFITHS.

Recommendation Committee—Drs. J. B. CLELAND and C. SAVILL WILLIS, and Mr. ALGERNON PEAKE.

During the year two meetings were held and papers read, as follows :—

12th June, 1917.

"The Disposal of the Dead by Cremation," by Dr. W. G. ARMSTRONG. (See "The Medical Journal of Australia," Vol. II, No. 4, 1917, p. 70).

10th July, 1917.

"The Teaching of Sex Hygiene," by Dr. C. S. WILLIS.

INDEX.

B

C

F

A CHECK-LIST OF THE MARINE FAUNA OF NEW SOUTH WALES.

PART I.

PREFACE BY CHARLES HEDLEY, F.L.S.

[*Supplement to Journal of the Royal Society of N.S.W., Vol. LI., 1917.*]

In the absence of complete monographs, check lists are the most serviceable aids to investigators. The needs of the last generation of students were met by a useful catalogue of the Marine Fauna of Sydney Harbour by Mr. T. Whitelegge. This was published as a prize essay by our Society twenty-eight years ago. Since then, steady progress in zoology has increased the total of known species by from a quarter to a half in various groups. Application of the rules of nomenclature and the proposal of new generic names have changed the names of the original series past recognition.

Therefore a new catalogue is required by those engaged in the study of local fauna. This the Council of the Royal Society of New South Wales have undertaken to provide by instalments as means and materials permit. In this production Professor Haswell, Dr. S. J. Johnston, Mr. T. Whitelegge and other zoologists have kindly agreed to assist the writer.

It is considered convenient to expand the geographic limits to agree with State boundaries, to include both vertebrata and invertebrata, and to leave the fluviatile fauna for another occasion. Thus arranged, it is hoped that the forthcoming catalogue may prepare the way for a zoological survey of New South Wales.

The present section on the Mollusca is presented first because the manuscript happened to be ready when the opportunity for printing occurred.

Study of the sea shells of this coast was commenced in 1770 by that favourite pupil of Linné, the accomplished conchologist Solander. Collecting was pursued in early colonial days by many able and enthusiastic resident naturalists such as Humphrey, Macleay, Paterson, Stutchbury, King, Strange and Macgillivray, while visitors like Péron, Lesson, Quoy, Gaimard and Stimpson did excellent work.

The first consecutive account of the marine mollusca of New South Wales was given by George French Angas. He based it on a collection gathered by himself during a residence of several years in Sydney, and subsequently identified in London by the aid of metropolitan specialists, museums and libraries. Under the title of "A List of Species of Marine Mollusca found in Port Jackson Harbour, New South Wales, and on the adjacent Coasts, with Notes on their Habits, &c.", it was issued in two parts in 1867 by the Zoological Society of London. About four hundred and fifty species were included.

On this foundation, Dr. J. C. Cox of Sydney compiled in 1868, "A list of species of Marine Mollusca found in Port Jackson Harbour and on the adjacent coasts." To the catalogue of Angas, he added about twenty names previously overlooked or subsequently discovered. Though privately printed, it was extensively circulated and has been quoted by von Martens and others as Cox's Exchange List.

In a first supplement (Proc. Zool. Soc. 1871, pp. 87-101) Angas added 108 species, and in a second (op. cit. 1877, pp. 178-194) he gave 186 more, thus raising the molluscan fauna known at that time to a total of 746 species.

Combining the discoveries of the Challenger Expedition with the work of Angas, Mr. T. Whitelegge in 1889

enumerated 802 marine mollusca in his list of Port Jackson invertebrata. No later list appeared. The present catalogue increases this to a total of above twelve hundred. The list has also been purified by formally discharging a number of species erroneously attributed to this fauna. Noteworthy among these is a block of Atlantic species which, by a mistake of Sir John Murray, was included in the Challenger series of 410 fathoms off Sydney. It is a moderate estimate to suppose that future research will recognise two thousand species of mollusca from the waters of this State. The time is at hand when local observers may ascend from enumeration and nomenclature to a study of habits and structure.

I am much indebted to Mr. T. Iredale for advice on nomenclature, and for notes on preoccupied names, such as Bulla australis and Purpura neglecta.

Sub-Kingdom MOLLUSCA.

Class PELECYPODA. (1—319).

Order PRIONODESMACEA. (1–101)

Family NUCULIDÆ.

PRONUCULA Hedley, Mem. Austr. Mus., iv., 1902, p. 290.

1—**decorosa** Hedley, Mem. Austr. Mus., 1902, p. 290, f. 39.

2—**hedleyi** Pritchard and Gatliff, Proc. Roy. Soc., Vict., xvii., 1904, p. 237; Nucula minuta Ten.-Woods, Proc. Roy. Soc. Tasm., 1876 (1877), p. 156; Hedley, Mem. Austr. Mus., iv., 1902, p. 291, f. 40.

NUCULA Lamarck, Mem. Soc. N.H., Paris, 1799, p. 87.

3—**consobrina** Adams and Angas, Proc. Zool. Soc., 1863, p. 427; Hedley, P.L.S.N.S.W., xxxviii, 1913, pl. 16, f. 1–3.

4—**obliqua** Lamarck, An. s. vert., vi. (i.), 1819, p. 59; Chenu, Man. Conch., ii, 1862, p. 179, f. 897; Hedley, P.L.S.N.S.W., xxviii, 1913, p. 263, pl. 16, f. 4–6; = N. simplex Adams, 1856, = anti-

podum Hanley, 1860, = N. dilecta Smith, 1891, = N. tenisoni Pritchard, 1896.

5—**pusilla** Angas, Proc. Zool. Soc., 1877, p. 177, pl. 26, f. 26.

6—**umbonata** Smith, Proc. Zool. Soc., 1891, p. 443, pl. 35, f. 24.

Angas erred (Proc. Zool. Soc., 1867, p. 932) in reporting the New Zealand N. strangei from New South Wales.

Family NUCULANIDÆ.

NUCULANA Link, Rostock Samml. iii., 1807, p. 155.

7—**crassa** Hinds, Nucula, Proc. Zool. Soc., 1843, p. 99; Hanley, Thes. Conch., iii, 1860, p. 120, pl. 228, f. 69.

8—**dohrni** Hanley, Leda, Proc. Zool. Soc., 1861, p. 242; L. hanleyi Angas, Proc. Zool. Soc., 1873, p. 184, pl. 20, f. 7.

9—**fortis** Hedley, Leda, Rec. Austr. Mus., vi, 1907, p. 362, pl. 66, f. 2, 3.

10—**inopinata** Smith, Leda, Chall. Zool., xiii, 1885, p. 236, pl. 19, f. 9. Not L. inopinata Cossmann, 1908.

11—**miliacea** Hedley, Leda, Mem. Austr. Mus., vi., 1902, p. 295, f. 43; Rec. Austr. Mus., vi., 1905, p. 42.

12—**pala** Hedley, Leda, Rec. Austr. Mus., vi., 1907, p. 361, pl. 66, f. 1.

13—**ramsayi** Smith, Leda, Chall. Zool., xiii., p. 241, pl. 20, f. 3.

POROLEDA, Tate, Proc. Roy. Soc., N.S.W., xxvii., 1894, p. 186.

14—**ensicula** Angas, Leda, Proc. Zool. Soc., 1877, p. 177, pl. 26, f. 27. = Leda lefroyi, Beddome, 1881.

15—**spathula** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 696, pl. 78, f. 17, 18.

SAREPTA, Adams, Ann. Mag. Nat. Hist., v., 1860, p. 303.

16—**obolella** Tate, Leda, Trans. Roy. Soc. S.A., viii., 1886, p. 129, pl. 5, f. 3; S. tellinaeformis, Hedley, Rec. Austr. Mus., iv., 1901, p. 26, f. 8.

Family ARCIDÆ.

CUCULLAEA, Lamarck, Syst. An., 1801, p. 116.

17—**concamera** Bruguiere, Arca, Encyl. Meth., vers i., 1789, p. 102; Adams Genera, 1857, pl. 125, f. 5; Hedley, P.L.S.N.S.W., xxix., 1904, p. 201.

LIMOPSIS, Sasso, Giorn. Ligust. Scien., i., 1827, p. 476.

18—**brazieri** Angas, Proc. Zool. Soc., 1871, p. 21, pl. 1, f. 34.

19—**erectus** Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 224, pl. 38, f. 14, 15.

20—**loringi** Angas, Proc. Zool. Soc., 1873, p. 183, pl. 20, f. 6; Brazier, P.L.S.N.S.W., vi., 1881, p. 789.

21—**tenisoni** Ten. Woods, Proc. Roy. Soc., Tasm., 1877, p. 56; L. bassi, Smith, Chall. Zool., xiii., 1885, p. 256, pl. 18, f. 6.

CYRILLA, Adams, Ann. Mag. Nat. Hist. (3), v., 1860, p. 478.

22—**dalli** Hedley, Mem. Austr. Mus., iv., 1902, p. 296, f. 44.

LISSARCA, Smith, Phil. Trans. clxviii., 1879, p. 185.

23—**picta** Hedley, Austrosarepta, P.L.S.N.S.W., xxiv, 1899, p. 430, f. 1, 2, and xxxiii., 1908, p. 472, Montacuta variegata Brazier nom. nud. P.L.S. N.S.W., xix., 1894, p. 179.

ARCA, Linne, Syst. Nat., x., 1758, p. 693.

24—**afra** Gmelin Syst. Nat., xiii., 1791, p. 3308; Lamy, Journ. de Conch., lv., 1907, p. 100; A. sculptilis, Reeve Conch. Icon., i., 1844, pl. 17, f. 118.

25—**botanica** Hedley, P.L.S.N.S.W., xli., 1917, p. 680, pl. 51, f. 33, 34, 35.

26—**fasciata** Reeve, Conch. Icon., ii., 1844, pl. 15, f. 99; Smith, Chall. Zool., xiii., 1885, p. 260.

27—**ventricosa** Lamarck, An. s. vert., vi., 1819, p. 38; Philippi Abbild Beschr., ii., 1847, p. 211, pl. 3, f. 4, 5. A. zebra, Hedley, P.L.S.N.S.W., xxvii., 1902, p. 17.

28—**metella,** Hedley, P.L.S.N.S.W., xli., 1917, p. 681, pl. 51, f. 36, 37.

29—**strabo** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 697, pl. 78, f. 19, 20.

30—**trapezia,** Deshayes, Mag. Zool., 1840, p. 21; A. lischkei, Hedley P.L.S.N.S.W., xxix., 1904, p. 203, pl. 9, f. 29, 34; Journ. Roy. Soc. N.S.W., xlix., 1915, p. 50, f. 14.

Angas (Proc. Zool. Soc. 1867, p. 931) erroneously records Barbatia pusilla from Sydney. Smith (Chall. Zool. xiii., p. 266) erroneously records A. gubernaculum from Sydney.

BATHYARCA, Kobelt, Conch. Cab., n.s., viii., pt. 2, Arca, 1891, p. 214.

31—**perversidens** Hedley, Mem. Austr. Mus., iv., 1902, p. 298, f. 45.

GLYCYMERIS, da Costa, Brit. Conch., 1778, p. 168.

32—**australis,** Quoy & Gaim. Pectunculus Zool. Astrolabe iii., 1834, p. 469, pl. 77, f. 7–9; = holosericus Reeve, 1843, = grayanus Dunker 1856; = kenyoniana Brazier 1898.

32a—**australis flammeus,** Reeve, Conch. Icon., i., 1843, pl. 2, f. 7; Hedley, P.L.S.N.S.W., xxv., 1900, p. 498.

33—**gealei** Angas, Pectunculus, Proc. Zool. Soc., 1873, p. 183, pl. 20, f. 5.

33—**tenuicostatus** Reeve, Pectunculus, Conch. Icon., i, 1843, pl. 6, f. 35; Lamy, Journ. de Conch., lix., 1912, p. 105, pl. 3, f. 3.

Smith (Chall. Zool., xiii., p. 251) erroneously recorded Pectunculus striatularis from Sydney.

Family PHILOBRYIDÆ.

CRATIS, Hedley, P.L.S.N.S.W., xxxix., 1915, p. 698.

35—**progressa** Hedley, op. cit., p. 698, pl. 79, f. 21–23.

PHILOBRYA, Carpenter, Smithson. Miscel. Coll., x., 1872, Index, p. 21.

36—**inornata** Hedley, P.L.S.N.S.W., xxix., 1904, p. 207, pl. 19, f. 40–43.

37—**parallelogramma** Hedley, op. cit., xxx., 1906, p. 544, pl. 32, f. 14–16.

38—**pectinata** Hedley, Mem. Austr. Mus., iv., 1902, p. 299, f. 46.

39—**tatei** Hedley, Rec. Austr. Mus., iv., 1901, p. 24, f. 6.

NOTOMYTILUS, Hedley, Austral. Antarctic Exped. Moll., 1916, p. 20.

40—**crenatuliferus** Tate, Myrina, Trans. Roy. Soc. S.A., xv., 1892, p. 131, pl. 1, f. 11.

41—**ruber,** Hedley, Philippiella, P.L.S.N.S.W., xxix., 1904, p. 207, pl. x., f. 44–47.

ADACNARCA, Pelseneer, Zool. Belgica Exped., 1903, Moll., p. 24.

42—**squamea** Hedley, Rec. Austr. Mus., vi., 1905, p. 45, f. 9.

Family PINNIDÆ.

PINNA, Linne Syst. Nat., x., 1758, p. 707.

43—**menkei** Reeve (as of Hanley, Nov. 1858) Conch. Icon., xi., June 1858, pl. 18, f. 34.

Family PERNIDÆ.

ISOGNOMON, Solander, Cat. Portland Museum, 1786, p. 9.

44—**cumingii** Reeve, Perna, Conch. Icon., xi., 1858, pl. 1, f. 3.

FORAMELINA, Hedley, Biol. Results Endeavour, ii., 1914, p. 70.

45—**exempla** Hedley, op. cit., p. 71, pl. 11, 12.

Family PTERIIDÆ.

PTERIA, Scopoli, Intr. Hist. Nat., 1777, p. 397.

46—**lata** Gray, Avicula, in Eyre Journ. Discov. Austr. ii., 1845, p. 435, pl. 6, f. 1; Smith, Alert. Zool. 1884, p. 112.

47—**maura** Reeve, Avicula, Conch. Icon., x., 1857, pl. 17, f. 72.

48—**pulchella** Reeve, Avicula, Conch. Icon., x., 1857, pl. 8, f. 22; Angas, Proc. Zool. Soc., 1867, p. 930.

PINCTADA, Bolten, Mus., Bolt., 1798, p. 166.

49—**vulgaris** Schumacher, Perlamater, Essai, 1917, p. 108, pl. 20, f. 8; Jameson, Proc. Zool. Soc., 1901, p. 384; M. fimbriata, Angas, Proc. Zool. Soc., 1867, p. 930.

MALLEUS, Lamarck, Mem. Soc., N.H., Paris, 1799, p. 82.

50—**albus** Lamarck, An. s. vert., 1819, p. 144; Chenu, Man. Conch., ii., 1862, f. 815.

51—**legumen** Reeve, Conch. Icon., xi., 1858, pl. 1, f. 2.

Family VULSELLIDÆ.

VULSELLA, Bolten, Mus. Bolt., 1798, p. 156.

52—**vulsella** Linne, Mya, Syst. Nat. x., 1758, p. 671; Smith, Proc. Malac. Soc., ix., 1911, p. 307, pl. 11.

Family OSTREIDÆ.

OSTREA, Linne, Syst. Nat., x., 1758, p. 696.

53—**angasi** Sowerby (emend), Conch. Icon., xviii., 1871, pl. 13, f. 27.

54—**cucullata** Born, Index Mus. Caes. Vind. 1778, p. 100; Sowerby, Conch. Icon., xviii., 1871, pl. 16, f. 34; = mordax, Gould, 1850, = glomerata, Gould, 1850, = subtrigona, Sowerby, 1871.

55—**virescens** Angas, Proc. Zool. Soc., 1867, p. 911, pl. 44, f. 13;.

Angas (Proc. Zool. Soc., 1867, p. 934) erroneously reported O. circumsuta Gould from Botany Bay.

Family TRIGONIIDÆ.

NEOTRIGONIA, Cossmann, Ann. Paleont., vii., 1912 p. 81.

56—**margaritacea** Lamarck, Trigonia, Ann. Mus., iv., 1804, p. 355, pl. 67, f. 2; Angas, Proc. Zool. Soc., 1877, p. 193; = antarctica, Peron, 1807, = pectinata, Lamarck, 1819, = nobilis, Adams, 1854.

56a—**margaritacea acuticostata** McCoy, Geol. Mag. iii., 1866, p. 481, f. 1; Chapman & Gabriel, Proc. Roy. Soc. Vict., xxvi., 1914, p. 305, pl. 26, f. 12, 13; = reticulata, Ten. Woods, P.L.S.N.S.W., ii., 1878, p. 125.

56b—**margaritacea lamarckii** Gray, Ann. Nat. Hist., i., 1838, p. 482; Chenu, Illustr. Conch., 1845, pl. 1.

57—**strangei** Adams, Trigonia, Proc. Zool. Soc., 1852 (1854), p. 91, pl. 16, f. 3.

Family PECTINIDÆ.

PECTEN, Muller, Zool. Dan. Prod., 1776, p. 161.

58—**medius** Lamarck, An. s. vert., vi., 1819, p. 163; Hedley, Mem. Austr. Mus., iv., 1902, p. 303; P. fumatus, Reeve, Conch. Icon., viii., 1852, pl. 7, f. 32.

CHLAMYS, Bolten, Mus. Bolt., 1798, p. 161.

59—**aktinos** Petterd, Proc. Roy. Soc. Tasm., 1886, p. 329; C. bednalli Hedley, P.L.S.N.S.W., xxv., p. 495, pl. 25, f. 10–13.

60—**antiaustralis** Tate, Trans. Roy. Soc. S.A., viii., 1886, p. 106, pl. 9, f. 7; Hedley, Biol. Results Endeavour, i., 1911, p. 96.

61—**asperrimus** Lamarck, An. s. vert., vi., 1819, p. 174; Delessert, Recueil, 1841, pl. 15, f. 1; Angas, Proc. Zool. Soc., 1877, p. 193; Ostrea matonii, Donovan, 1825, = P. australis, Sowerby 1847.

62—**bifrons** Lamarck, An. s. vert., vi., 1819, p. 164; Delessert, Recueil, 1841, pl. 15, f. 5; Hedley, Biol. Results Endeavour, ii., 1914, p. 73.

63—**blandus** Reeve, Conch. Icon., viii., 1853, pl. 34, f. 162; Tapparone Canefri, Zool. Magenta, 1873, p. 253.

64—**challengeri** Smith, Proc. Zool. Soc., 1891, p. 443, pl. 35, f. 25.

65—**hedleyi** Dautzenberg, Journ. de Conch., xlix., 1901, p. 348 for C. fenestrata, Hedley (not Forbes), P.L.S.N.S.W., xxv., 1900, p. 730, pl. 48, f. 17–19.

66—**lividus** Lamarck, An. s. vert., vi., 1819, p. 178; Ostrea tegula Wood, Index, Test. 1828, p. 206, suppl. pl. 2, f. 3; Angas, Proc. Zool. Soc., 1867, p. 933; P. foliaceus, Quoy & Gaim., Zool. Astrolabe iii., 1835, p. 445, pl. 76, f. 4–6.

AMUSIUM, Bolten, Mus. Bolt., 1798, p. 165.

67—**japonicum** Gmelin, Ostrea, Syst. Nat., xiii., 1791, p. 3317; P. balloti, Bernardi, Journ. de Conch., ix., 1861, p. 46, pl. 1, f. 1; Angas, Proc. Zool. Soc., 1877, p. 193.

68—**thetidis** Hedley, Mem. Austr. Mus., iv., 1902, p. 304, f. 49; Rec. Austr. Mus., vi., 1906, p. 223, pl. 38, f. 18, 19.

CYCLOPECTEN, Verrill, Trans. Connect. Acad., x., 1899, p. 70.

69—**favus** Hedley, Mem. Austr. Mus., iv., 1902, p. 305, f. 50; = nepeanensis, Pritchard & Gatliff, 1904.

70—**obliquus**, Hedley, op. cit., p. 306, f. 51.

Family SPONDYLIDÆ.

SPONDYLUS, Linne Syst. Nat., x., 1758, p. 690.

71—**tenellus**, Reeve, Conch. Icon., ix., 1856, pl. 18, f. 67; Fulton, Journ of Conch., xiv., 1915, p. 354.

PLICATULA, Lamarck, Syst. Nat., 1801, p. 132.

72—**australis** Lamarck, An. s. vert., vi., 1819, p. 185; Hanley, Cat. Rec. Shells 1856, p. 288, pl. 24, f. 44.

Family DIMYIDÆ.

DIMYA, Rouault, Mem. Soc. Geol. France, (2), iii., 1848, p. 471.

73—**corrugata** Hedley, Mem. Austr. Mus., iv., 1902, p. 308, f. 52.

Family LIMIDÆ.

LIMA, Bruguiere, Encycl. Meth. Tabl. vers, 1797, pl. 206.

74—**angulata** Sowerby, Thes. Conch., i., 1843, p. 86, pl. 22, f. 39, 40; Smith, Chall. Zool., xiii., 1885, p. 289.

75—**australis** Smith, Proc. Zool. Soc., 1891, p. 444, pl. 35, f. 27.

76—**bassii** Ten. Woods, Proc. Roy. Soc. Tasm., 1876, p. 112; Hedley, P.L.S.N.S.W., xxix., 1904, p. 201, pl. 9, f. 28.

77—**multicostata** Sowerby, Thes. Conch., i., 1843, p. 85, pl. 22, f. 38; Smith, Chall. Zool., xiii., 1885, p. 288.

78—**orientalis** Adams & Reeve, Zool. Samarang, 1850, p. 75, pl. 11, f. 33; Angas, Proc. Zool. Soc., 1871, p. 101.

79—**strangei** Sowerby, Conch. Icon., xviii., 1872, pl. 3, f. 15; Radula bullata. Angas, Proc. Zool. Soc., 1867, p. 933.

80—**sydneyensis** Hedley, P.L.S.N.S.W., xxix., 1904, p. 200, L. brunnea, Hedley (not Cooke, 1886), op. cit. xxvi., 1901, p. 21, pl. 2, f. 7–9.

LIMEA, Bronn. Ital. Tert. 1831, p. 115.

81—**murrayi** Smith, Proc. Zool. Soc., 1891, p. 444, pl. 35, f. 26; L. acclinis, Hedley, Rec. Austr. Mus. vi., 1905, p. 46, f. 10.

Family ANOMIIDÆ.

MONIA, Gray, Proc. Zool. Soc., 1849 (1850), p. 121.

82—**ione** Gray, Proc, Zool., Soc., 1849, p. 123; Reeve, Conch. Icon., xi., 1859, pl. 2, f. 6.

ANOMIA, Linné Syst. Nat., x., 1758, p. 700.

83—**walteri** Hector, Trans. N.Z. Inst., xxvii., 1895, p. 292; Suter, Man. N.Z. Moll, 1913, p. 844, pl. 57, f. 10.

Family MYTILIDÆ.

MYTILUS, Linne, Syst. Nat., x., 1758, p. 704.

84—**planulatus** Lamarck, An. s. vert., vi., 1819, p. 125; M. dunkeri, Reeve, Conch. Icon., x., 1857, pl. 5, f. 17.

BRACHYODONTES, Swainson, Malac., 1840, p. 384, emend. Herrmannsen, 1846.

85—**hirsutus** Lamarck, Mytilus, An. s. vert., vi., 1819, p. 120; Reeve, Conch. Icon., x., 1857, pl. 3, f. 8; Smith, Chall. Zool. xiii., 1885, p. 273.

MODIOLUS, Lamarck, Mem. Soc. N.H. Paris, 1799, p. 87.

86—**albicostus** Lamarck, An. s. vert., vi., 1819, p. 111; Delessert Recueil, 1841, pl. 13, f. 8.

87—**arborescens** Dillwyn, Mytilus, Descrip. Cat. i., 1817, p. 306; Reeve, Conch. Icon., x., 1857, pl. 6, f. 30; = M. pictus, Lamarck, 1819.

88—**australis** Gray in King Survey Austr., ii., 1827, p. 477; Reeve, Conch. Icon., x., 1857, pl. 5, f. 21.

89—**confusus** Angas, Perna, Proc. Zool. Soc., 1871, p. 21, pl. 1, f. 33.

90—**glaberrimus** Dunker, Volsella, Proc. Zool. Soc., 1856 (May, 1857), p. 363; Reeve, Conch. Icon., x., Oct., 1857, pl. 8, f. 48.

91—**lineus** Hedley, Rec. Austr. Mus., vi., 1906, p. 300, pl. 56, f. 23–5.

MUSCULUS, Bolten, Mus. Bolt., 1798, p. 156.

92—**barbatus** Reeve, Lithodomus, Conch. Icon., x., 1858, pl. 5, f. 27; Smith, Chall. Zool., xiii., 1885, p. 278.

93—**cumingianus** Reeve, Modiola, Conch. Icon., x., 1857, pl. 9, f. 50; Angas, Proc. Zool. Soc., 1871, p. 101.

94—**cuneatus** Gould, Proc. Boston Soc. Nat. Hist., viii., 1861, p. 38; Smith, Chall. Zool. xiii., 1885, p. 278, pl. 16, f. 7.

95—**recens** Tate, Arcoperna, Proc. Malac. Soc., ii., 1897, p. 182, figs; Hedley, Proc. L.S.N.S.W., xxv., 1900, p. 496.

96—**scapha** Verco, Arcoperna, Trans. Roy. Soc. S.A., xxxii., 1908, p. 196, pl. 12, f. 1–5; Chapman & Gabriel, Proc. Roy. Soc. Vict. xxvi., 1914, p. 307, pl. 27, f. 16.

97—**splendidus** Dunker, Volsella, Proc. Zool. Soc., 1856 (1857) p. 365; Reeve, Lithodomus, Conch. Icon., x., 1858, pl. 5, f. 31; Hedley, P.L.N.S.W., xxvi., 1902, p. 706, pl. 34, f. 1.

98—**subtortus** Dunker, Modiolarca, Proc. Zool. Soc., 1856 (1857), p. 365; Reeve, Modiola, Conch. Icon., x., 1858, pl. 10, f. 57; Angas, Proc. Zool. Soc., 1867, p. 930.

99—**varicosus** Gould, Modiola, Proc. Boston Soc. Nat. Hist., viii., 1861, p. 37; Smith, Zool. Alert, 1884, p. 109, pl. 7, f. M.

DACRYDIUM Torrell, Fauna Moll. Spitzb. i., 1859, p. 138.

100—**fabale** Hedley, P.L.S.N.S.W., xxix., 1904, p. 199, pl. 10, f. 39.

SEPTIFER, Recluz, Rev. Zool., 1848, p. 275.

101—**bilocularis** Linné, Mytilus, Syst. Nat., x., 1758, p. 705; Reeve, Conch. Icon., x., 1857, pl. 9, f. 40; Angas Proc. Zool. Soc., 1877, p. 192, as M. kraussi.

Order ANOMALODESMACEA (102–142).

Family LATERNULIDÆ.

LATERNULA, Bolten, Mus. Bolt., 1798, p. 155.

102—**creccina** Reeve, Anatina, Conch. Icon., xiv., 1860, pl. 2, f. 12; ? attenuata, Reeve, op. cit., pl. 3, f. 16; Angas, Proc. Zool. Soc., 1867, p. 913.

103—**prolongata** Reeve, Anatina, Conch. Icon., xiv., 1863, errata, Pl. 4, f. 28; Angas, Proc. Zool. Soc., 1867, p. 914.

Family PERIPLOMATIDÆ.

PERIPLOMA, Schumacher, Essai Nouv. Syst., 1817, p. 115.

104—**micans** Hedley, Rec. Austr. Mus., iv., 1901, p. 25, f. 7.

COCHLODESMA, Couthouy, Boston Journ. Nat. Hist., ii., 1839, p. 70.

105—**angasi** Crosse & Fischer, Periploma, Journ. de Conch., xii., 1864, p. 349, and xiii., 1865, p. 427, pl. 11, f. 1; Brazier, P.L.S.N.S.W., ii., 1878, p. 371.

Family THRACIIDÆ.

THRACIA, Blainville, Dict. Sc. Nat., xxxii., 1824, p. 347.

106—**anatinoides** Reeve, Conch Icon., xii., 1859, pl. 3, f. 12.

107—**angasiana** Smith, Journ. Linn. Soc. Zool., 1876, p. 560, pl. 30, f. 23.

108—**brazieri** Sowerby, Proc. Zool. Soc., 1883 (1884), p. 465, nom. mut. for jacksonensis, Sowerby, op. cit., p. 30, pl. 7, f. 5.

109—**jacksoniana** Smith, Journ. Linn. Soc. Zool., xii., 1876, p. 561, pl. 30, f. 24.

110—**modesta** Angas, Proc. Zool. Soc., 1867, p. 908, pl. 44, f. 3.

THRACIOPSIS, Tate & May, Trans. Roy. Soc. S.A., xxiv., 1900, p. 103.

111—**angustata** Angas, Alicia, Proc. Zool. Soc., 1867, p. 908, pl. 44, f. 1; ? Thracia cultrata Gould, Proc. Boston Soc. Nat. Hist., viii., 1861, p. 23; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 266.

112—**arenosa** Hedley, P.L.S.N.S.W., xxix., 1904, p. 197, pl. 9, f. 26–7.

113—**elegantula** Angas, Alicia, Proc. Zool. Soc., 1867, p. 908, Pl. 44, f. 2.

114—**speciosa** Angas, Thracia, Proc. Zool. Soc., 1869, p. 48, pl. 2, f. 12.

Family MYOCHAMIDÆ.

MYOCHAMA, Stutchbury, Zool. Journ., v., 1830, p. 96.

115—**anomioides** Stutchbury, op. cit., p. 97, suppl., pl. 42, f. 1–4; Smith, Chall. Zool. xiii., 1885, p. 63.

116—**strangei** Adams, Proc. Zool. Soc., 1850, p. 23, pl. 8, f. 2.

MYODORA, Gray (emend.), Ann. Nat. Hist., 1840, p. 306.

117—**albida** Ten. Woods, Proc. Roy. Soc. Tasm., 1875 (1876), p. 160; Hedley, Rec. Austr. Mus., vi., 1907, p. 301; M. corrugata, Verco, Trans. Roy. Soc. S.A., xx., 1896, p. 229, pl. 8, f. 1.

118—**australica** Reeve, Thracia, Conch. Icon., xii., 1859, pl. 3, f. 13; Smith, Chall. Zool., xiii., 1885, p. 67.

119—**brevis** Sowerby, Pandora, Append. Stutch. Cat. (cir. 1829), p. 3, f. 2; Smith, Proc. Zool Soc., 1880, p. 580.

120—**crassa** Stutchbury, Anatina, Zool. Journ., v., 1830, p. 100, pl. suppl. 43, f. 5, 6.

121—**ovalis**, Stutchbury, Anatina, Zool. Journ., v., 1830, p. 100, pl. suppl. 43, f. 7–8.

122—**ovata** Reeve, Conch. Icon., ii., 1844, pl. 1, f. 4.

123—**pandoriformis** Stutchbury, Zool. Journ., v., 1830, p. 99, pl. suppl. 43, f. 3–4; Smith, Chall. Zool., xiii., 1885, p. 64.

Family CLEIDOTHAERIDÆ.

CLEIDOTHÆRUS, Stutchbury, Zool. Journ., v., 1830, p. 97.

124—**albidus** Lamarck, Chama. An. s. vert., vi., 1819, p. 96; Chenu, Illustr. Conchyl., 1845, pl. 1; Hancock, Ann. Mag. Nat. Hist. (2), xi., 1853, p. 106, pls. 3–4; = C. chamoides, Stutchbury, 1830; = C. crassa, Tate, 1884.

Family CLAVAGELLIDÆ.

DACOSTA, Gray, Proc. Zool. Soc., 1858, p. 315.

125—**australis** Sowerby Clavagella, Append. Stutchbury Cat. (cir. 1829), pl. 1, f. 1; Tryon Am. Journ. Conch., iii., 1868, Suppl. p. 5 = C. elongata, Broderip, 1835.

HUMPHREYIA, Gray, Ann. Mag. Nat. Hist. (3), ii., July 1858, p. 16.

126—**coxi** Brazier, Proc. Zool. Soc., 1872, p. 22, pl. 4, f. 9.

127—**strangei** Adams, Aspergillum, Proc. Zool. Soc., 1852 (1854), p. 91, pl. 15, f. 5; Smith, P. Malac. Soc., ix., 1910, p. 23, f. 1–3.

Family VERTICORDIIDÆ.

VERTICORDIA, Sowerby, Min. Conch., 1844, p. 639.

128—**australiensis** Smith, Chall. Zool., xiii., 1885, p. 167, pl. 25, f. 6; Hedley, Rec. Austr. Mus., vi., 1907, p. 303, pl. 56, f. 38–39.

129—**ericia** Hedley, Biolog. Results Endeavour, i., 1911, p. 96, pl. 17, f. 1–3.

130—**setosa** Hedley, Rec. Austr. Mus., vi., 1907, p. 303. V. rhomboides, Hedley (not Tate 1887). Trans. N.Z. Inst. xxxviii., 1905 (1906), p. 71, pl. 2, f. 13, 14.

131—**vadosa** Hedley, Rec. Austr. Mus., vi., 1907, p. 303, pl. 56, f. 34–37.

LYONSIELLA, Sars, Remark. Forms Life, 1872, p. 25.
132—**quadrata** Hedley, Rec. Austr. Mus., vi., 1907, p. 302, pl. 56, f. 31–33.

Family POROMYACIDÆ.

POROMYA, Forbes, Rep. Brit. Assoc., 1844, p. 103.
133—**undosa** Hedley and Petterd, Rec. Austr. Mus., vi., 1906, p. 224, pl. 38, f. 16–17.
134—**illevis,** Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 265; Ectorisma granulata, Tate, Trans. Roy. Soc. S. Aust., xv., 1892, p. 127, pl. 1, f. 3, 3a.

Smith (Proc. Malac Soc., i., 1894, p. 60) has erroneously recorded Poromya naeroides, Seguenza from this coast.

Family CUSPIDARIIDÆ.

CUSPIDARIA, Nardo, Revue Zool., 1840, p. 30.
135—**alveata** Hedley, Rec. Austr. Mus., vi., 1907, p. 362, pl. 66, f. 6.
136—**angasi** Smith, Neæra, Chall. Zool., xiii., 1885, p. 47, pl. 9, f. 2.
137—**brazieri** Smith, Neæra, Chall. Zool., xiii., 1885, p. 51, pl. 9, f. 3.
138—**dorsirecta** Verco, Trans. Roy. Soc. S.A., xxxii., 1908, p. 198, pl. 11, f. 9, 10.
139—**exarata** Verco, Trans. Roy. Soc. S.A., xxxii., 1908, p. 199, pl. 12, f. 6, 7.
140—**latesulcata** Ten. Woods, Neæra, P.L.S.N.S.W., ii., 1877, p. 123; Hedley, P.L.S.N.S.W., xxvi., 1901, p. 20, pl. 2, f. 11–13.
141—**tasmanica** Ten. Woods, Neæra, Proc. Roy. Soc. Tasm., 1875 (1876), p. 27; Hedley, P.L.S.N.S.W., xxvi., 1901, p. 21, f. 20.
142—**truncata** Hedley, Rec. Austr. Mus., vi., 1905, p. 47, f. 11.

Smith (Proc. Malac. Soc., i., 1894, p. 60) has erroneously recorded Cuspidaria teres Jeffreys from this coast. Angas (Proc. Zool. Soc., 1867, p. 914) wrongly cited Neæra rugata, Adams.

Order TELEODESMACEA (143–319).

Family CRASSATELLITIDÆ.

CRASSATELLITES, Kruger, Arch. neust. Entd. Urweldt., ii., 1823, p. 466.

143—**discus** Hedley, Rec. Austr. Mus., vi., 1907, p. 300, pl. 56, f. 26, 27.

144—**fulvidus** Angas, Crassatella, Proc. Zool. Soc., 1871, p. 20, pl. 1, f. 32.

145—**kingicola** Lamarck, Crassatella, Ann. Mus., v., 1804, p. 408; Lamy, Journ. de Conch., lxii., 1917, pl. vi., fig. 1; Brazier, P.L.S.N.S.W., xiv., 1900, p. 749, = sulcata, Lamarck, 1804, = C. lamarcki, Deshayes.

145a—**kingicola corbuloides** Reeve, Proc. Zool. Soc., 1842, p. 45; Conch. Icon., i., 1843, pl. ii., fig. 9.

146—**scabriliratus** Hedley, Mem. Austr. Mus., iv., 1902, p. 314, f. 54.

147—**securiformis** Hedley, op. cit., p. 312, f. 53.

CUNA, Hedley, Mem. Austr. Mus., iv., 1902, p. 314.

148—**atkinsoni** Ten. Woods, Kellia, Proc. Roy. Soc. Tasm., 1876 (1877), p. 158; Tate & May, P.L.S.N.S.W., xxvi., 1901, p. 435, pl. 27, f. 107.

149—**concentrica** Hedley, Mem. Austr. Mus., iv., 1902, p. 315, f. 55, not C. concentrica, Bartsch, 1915.

150—**delta** Tate & May, Carditella, Trans. Roy. Soc. S.A., xxiv., 1900, p. 102; Hedley, Rec. Austr. Mus., iv., 1901; p. 23, f. 5.

151—**particula** Hedley, Mem. Austr. Mus., iv., 1902, p. 316, f. 56.

152—**pisum** Hedley, P.L.S.N.S.W., xxxiii., 1903, p. 476, pl. 9, f. 26, 27.

HEMIDONAX, Morch, Mal. Blatt, xvii., 1870, p. 121.

153—**australiensis** Reeve, Cardium. Conch. Icon., ii., 1844, pl. 5, f. 24; Donax pictus, Tryon, Am. Journ. Conch., ii., 1870, p. 23, pl. 1, f. 1.

Family CARDITIDÆ.

CARDITELLA, Smith, Proc. Zool. Soc., 1881, p. 42.

154—**angasi** Smith, Chall. Zool., xiii., 1885, p. 217, pl. 15, f. 9.

155—**elegantula** Tate & May, P.L.S.N.S.W., xxvi., 1901, p. 463, f. 14.

CARDITA, Bruguiére, Ency. Meth., vers. (2), 1792, p. 401.

156—**calyculata,** Linn. Chama, Syst. Nat., x., 1758, p. 692; C. excavata Desh., Proc. Zool. Soc., 1852 (1854), p. 100, pl. xvii., fig. 1, 2, 3; Lamy, Bull. Mus. Hist., 1916, p. 119.

VENERICARDIA, Lamarck, Syst. An. s. vert., 1801, p. 123.

157—**amabilis** Deshayes, Cardita, Proc. Zool. Soc., 1852, p. 102, pl. 17, f. 8, 9; Angas, Proc. Zool. Soc., 1871, p. 100.

158—**beddomei** Smith, Chall. Zool., xiii., 1885, p. 211, pl. 15, f. 5; Hedley, P.L.S.N.S.W., xxv., 1900, p. 499.

159—**calva** Tate, Cardita, Trans. Roy. Soc. S.A., ix., 1887, p. 189, pl. 20, f. 14; Gatliff & Gabriel, Proc. Roy. Soc., Vict., xxv., 1912, p. 173; C. dilecta, Hedley, Rec. Austr. Mus., vi., 1905, p. 41.

160—**cavatica** Hedley, Cardita, Mem. Austr. Mus., iv., 1902, p. 318, f. 58.

161—**raouli** Angas, Proc. Zool. Soc., 1872, p. 613, pl. 42, f. 12; Hedley, Biol. Results Endeavour, ii., 1914, p. 73.

Family CONDYLOCARDIIDÆ.

CONDYLOCARDIA, Bernard, Bull. Mus. Hist. Nat., ii., 1896, p. 195.

162—**ovata** Hedley, P.L.S.N.S.W., xxx., 1906, p. 539, pl. 31, f. 5, 6.

163—**pectinata** Tate & May, Carditella, Trans. Roy. Soc., S.A., xxiv., 1900, p. 103; Hedley & May, Rec. Austr. Mus., vii., 1908, p. 125, pl. 25, f. 43, 44, 45.

164—**porrecta** Hedley, P.L.S.N.S.W., xxxi., 1906, p. 475, pl. 38, f. 24; Hedley & May, Rec. Austr. Mus., vii., 1908, p. 125, pl. 25, f. 41, 42.

165—**projecta** Hedley, Mem. Austr. Mus., iv., 1902, p. 317, f. 57.

166—**trifoliata** Hedley, P.L.S.N.S.W., xxxi., 1906, p. 475, pl. 37, f. 21–23.

Family CHAMIDÆ.

CHAMA, Linné, Syst. Nat., x., 1758, p. 691.

167—**fibula** Reeve, Conch. Icon., iv., 1846, pl. 5, f. 27; Hedley, P.L.S.N.S.W., xli., 1917, p. 682.

From Sydney, Angas (Proc. Zool. Soc., 1867, p. 295, and 1871, p. 100) erroneously cited C. spinosa, Broderip, and C. reflexa, Reeve.

Family LUCINIDÆ.

CODAKIA, Scopoli, Intr. Hist. Nat., 1777, p. 398.

168—**bella** Conrad, Lucina, Journ. Acad. Sci. Philad., vii., 1834, p. 254; L. fibula, Angas, Proc. Zool. Soc., 1877, p. 192; = L. divergens Philippi, 1850, = L. munda, Adams, 1856.

169—**pisidium** Dunker, Lucina, Malak. Blatt., vi., 1860, p. 227; Hedley, P.L.S.N.S.W., xxxix., 1914, p. 699, pl. 79, f. 25, 28.

170—**quadrata** Angas, Lucina, Proc. Zool. Soc., 1877, p. 176, pl. 26, f. 24.

171—**rugifera** Reeve, Lucina, Conch. Icon., vi., 1850, pl. 1, f. 1; Angas, Proc. Zool. Soc., 1867, p. 926.

172—**simplex** Reeve, Lucina, Conch. Icon., vi., 1850, pl. 3, f. 11; Angas, Proc. Zool. Soc., 1867, p. 926.

LUCINA, Bruguiére, Ency. Meth. Tabl. vers., 1797, pl. 284.

173—**induta** Hedley, Rec. Austr. Mus., vi., 1907, p. 363, pl. 66, f. 11, 12.

LUCINIDA, D'Orbigny, Voy. Amer. Merid., 1847, p. 588.

174—**assimilis** Angas, Loripes, Proc. Zool. Soc., 1867, p. 910, pl. 44, f. 8; L. jacksoniensis, Smith, Chall. Zool., xiii., 1885, p. 185, pl. 13, f. 11.

175—**hilaira** Hedley, P.L.S.N.S.W., xli., 1917, p. 683, pl. 51, f. 38, 39.

176—**ramsayi** Smith, Chall. Zool., xiii., 1885, p. 174, pl. 13, f. 2; Hedley, Rec. Austr. Mus., viii., 1912, p. 133.

Cooke (Ann. Mag. N.H. (5), xviii., 1886, p. 99), erroneously cites from Port Jackson, Lucina globosa, Forskal. Vide Lynge, D. Kgl. Danske Vidensk. Selsk, Shrifter 7, t.v. 1909, p. 175.

MYRTAEA, Turton, Dithyr, Brit., 1822, p. 133.

177—**botanica** Hedley, 1918 (nom. mut.), Tellina brazieri, Sowerby, Proc. Zool. Soc., 1883, p. 31, pl. 7, f. 2, not Tellina brazieri, Sowerby, 1869.

DIVARICELLA, von Martens, Beitr. Meersf. Mauritius, 1880, p. 321.

178—**cumingi** Adams & Angas, Lucina, Proc. Zool. Soc., 1863, p. 426, pl. 37, f. 20; Smith, Chall. Rep., xiii., 1885, p. 177.

CORBIS, Cuvier, Regn. Anim., ii., 1817, p. 480.

179—**despecta** Hedley, Chione, P.L.S.N.S.W., xxix., 1904, p. 193, pl. 10, f. 35–8.

Family DIPLODONTIDÆ.

DIPLODONTA, Bronn, Ital. Tertiar, geb., 1831, p. ix.

180—**adamsi** Angas, Mysia, Proc. Zool. Soc., 1867, p. 910, pl. 44, f. 9.

181—**jacksoniensis** Angas, Mysia, Proc. Zool. Soc., 1867, p. 910, pl. 44, f. 10.

182—**globulosa** Adams, Proc. Zool. Soc., 1855, p. 226; Angas, Proc. Zool. Soc., 1867, p. 927.

183—**zelandica** Gray in Yate, New Zealand, 1835, append. p. 309; Hedley, P.L.S.N.S.W., xxix., 1904, p. 196.

Family CYRENELLIDÆ.

JOANNISIELLA, Dall, Nautilius, ix., 1895, p. 78.

184—**sphaericula** Deshayes, Cyrenella, Proc. Zool. Soc., 1854 (1855), p. 340; Hedley, P.L.S.N.S.W., xxx., 1906, p. 544, pl. 32, f. 18–21.

Family THYASIRIDÆ.

THYASIRA, Lamarck, An. s. vert., v., 1818, p. 492.

185—**albigena** Hedley, Rec. Austr. Mus., vi., 1907, p. 363, pl. 66, f. 4–5.

186—**flexuosa** Montagu, Tellina, Test. Britt., 1803, p. 72; Brazier, P.L.S.N.S.W., xix., 1895, p. 725.

Family LEPTONIDÆ.

ERYCINA, Lamarck, Ann. du Mus., vii., 1806, p. 53.

187—**acupuncta** Hedley, Mem. Austr. Mus., iv., 1902, p. 321, f. 60.

188—**helmsi** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 701, pl. 80, f. 37–9.

BORNIA, Philippi, Moll. utr. Sicil., i., 1836, p. 13.

189—**filosa** Hedley, P.L.S.N.S.W., xxvii., 1902, p. 7, pl. 2, f. 15–17.

190—**lepida** Hedley, P.L.S.N.S.W., xxx., 1906, p. 543, pl. 32, f. 22, 23.

191—**radiata** Hedley, Rec. Austr. Mus., vi., 1905, p. 48, f. 12.

NEOLEPTON, Monterosato, Atti. Acad. Palermo, 1875, p. 12.

192—**novacambrica** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 701, pl. 79, f. 29–32.

KELLYA, Turton, emend, Dithyra Brit., 1822, p. 56.

193—**adamsi** Angas, Lepton, Proc. Zool. Soc., 1867, p. 910, pl. 44, f. 11.

194—**jacksoniana** Smith, Zool. Coll. Alert, 1884, p. 105, pl. 7, f. F.

195—**solida** Angas, Proc. Zool. Soc., 1877, p. 176, pl. 26, f. 25.

196—**suborbicularis** Montagu, Mya, Test. Brit., 1804, p. 39, pl. 26, f. 6; Hedley, P.L.S.N.S.W., xxx., 1906, p. 543; K. rotunda, Angas, Proc. Zool. Soc., 1867, p. 927.

ROCHEFORTIA, Velain (Compt. Rend., lxxxiii., 1876, p. 285, nom. nud.), Archiv. Zool. Exper., vi., 1877, p. 132.

197—**angasi** Smith, Montacuta, Chall. Zool., xiii., 1885, p. 204, pl. 12, f. 2.

198—**anomala** Angas, Mysella, Proc. Zool. Soc., 1877, p. 176, pl. 26, f. 22.

199—**concentrica** Gould, Lepton, Proc. Bost. Soc., Nat. Hist., viii., 1861, p. 33; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 700, pl. 77, f. 1.

200—**donaciformis** Angas, Mysella, Proc. Zool. Soc., 1878, p. 863, pl. 54, f. 13; Hedley, P.L.S.N.S.W., xxvii., 1902, p. 7, pl. 1, f. 10–14.

201—**lactea** Hedley, Mem. Austr. Mus., iv., 1902, p. 320, f. 59.

202—**subacuminata** Smith, Tellimya, Proc. Zool. Soc., 1891, p. 442, pl. 35, f. 22.

LASAEA, Brown, Ill. Conch. Gt. Britain, 1827, Explan. pl. 20, f. 18.

203—**australis** Lamarck, Cyclas, An. s. vert., v., 1818, p. 560; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 702, and Mollusca Austral. Antarctic Exped., 1916, p. 33, pl. 4, f. 45, 46.

CORIAREUS, Hedley, Rec. Austr. Mus., vi., 1907, p. 301.

204—**vitreus** Hedley, op. cit. pl. 56, f. 28, 30.

205—**semiradiatus** Tate, Montacuta, Trans. Roy. Soc S.A., xi., 1889, p. 63, pl. 40, f. 2; Hedley, P.L.S.N.S.W., xxx., 1906, p. 542, pl. 31, f. 1, 2.

MYLITTA, D'Orb. & Recluz, Journ. de Conch., i., 1850, p. 288.

206—**tasmanica** Ten. Woods, Pythina, Proc. Roy. Soc. Tasm., 1875 (1876), p. 162; Tate, Trans. Roy. Soc. S.A., ix., 1887, p. 98, pl. 5, f. 12; Brazier, P.L.S.N.S.W., xviii., 1894, p. 433.

Family KELLIELLIDÆ.

CYAMIOMACTRA, Bernard, Bull. Mus. Hist. Nat., 1897, p. 311.

207—**balaustina** Gould,, Kellia, Proc. Bost. Soc. Nat. Hist., viii., 1861, p. 33; C. nitida, Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 477, pl. 9, f. 19, 20, and xxxix., 1915, p. 699, pl. 77, f. 2, 3.

208—**communis** Hedley, P.L.S.N.S.W., xxx., 1906, p. 541, pl. 31, f. 11–13.

209—**mactroides** Tate & May, Cyamium, Trans. Roy. Soc. S.A., xxiv., 1900, p. 102; Hedley, P.L.S.N.S.W., xxx., 1906, p. 541, pl. 31, f. 9, 10.

Family GALEOMMATIDÆ.

SOLECARDIA, Conrad, Proc. Acad. Nat. Sci., Philad., iv., 1849, p. 155.

210—**cryptozoica** Hedley, P.L.S.N.S.W., xli., 1917, p. 684, pl. 51, f. 40.

211—**strangei** Deshayes, Scintilla, Proc. Zool. Soc., 1855 (1856), p. 181; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 268, pl. 16, f. 17-19.

From Sydney, Angas (Proc. Zool. Soc., 1867, p. 928) erroneously recorded Scintilla anomala, Deshayes.

Family CARDIIDÆ.

CARDIUM, Linné, Syst. Nat., x., 1758, p. 678.

212—**bechei** Reeve, Proc. Zool. Soc., 1847, p. 25; Dunker, Index Moll. Mar. Jap., 1882, p. 212, pl. 15, f. 1, 2, 3; Hedley, P.L.S.N.S.W., xxix., 1904, p. 195.

213—**cygnorum** Deshayes, Proc. Zool. Soc., 1854, p. 331; Hedley, P.L.S.N.S.W., xli., 1917, p. 686, pl. 52, f. 41.

214—**flavum** Linné Syst. Nat., x., 1758, p. 680; C. rugosum Lamarck, An. s. vert., vi., 1819, p. 19; Reeve, Conch. Icon., ii., 1845, pl. 14, f. 68; Angas, Proc. Zool. Soc., 1877, p. 192.

215—**lævigatum** Linné Syst. Nat., x., 1758, p. 680; Hanley, Ips. Linn. Conch., 1855, p. 51, pl. 1, f. 8; C. papyraceum, Angas, Proc. Zool. Soc., 1867, p. 925.

216—**multispinosum** Sowerby, Proc. Zool. Soc., 1840; p. 106; Reeve, Conch. Icon., ii., 1844, pl. 2, f. 10; Angas, Proc. Zool. Soc., 1877, p. 192.

217—**pulchellum** Gray in Dieffenbach, New Zealand, ii., 1843, p. 252; Reeve, Conch. Icon., ii., 1844, pl. 8, f. 42; Angas, Proc. Zool. Soc.; 1867, p. 925.

218—**rackettii** Donovan, Nat. Repository, iv., 1826, p. 124; Hedley, P.L.S.N.S.W., xli., 1917, p. 685.

219—**setosum** Redfield, Ann. N.Y. Lyceum, iv., 1846, p. 168, pl. 11, f. 1; Smith, Chall. Zool., xiii., 1885, p. 158.

Smith (Chall. Zool., xiii., 1885, p. 159) has erroneously reported C. tenuicostatum from Sydney.

Family VENERIDÆ.

DOSINIA, Scopoli, Intr. Hist. Nat., 1777, p. 399.

220—**circinaria** Deshayes, Cat. Conchif. Brit. Mus., 1853, p. 9; Smith, Chall. Zool., xiii., 1885, p. 150, pl. 1, f. 2.

221—**crocea** Deshayes, Cat. Conchif. Brit. Mus., 1853, p. 8; Roemer, Monog, 1862, p. 71, pl. xiii., f. 4; Hedley, P.L.S.N.S.W., xli., 1917, p. 688.

222—**puella** Angas, Proc. Zool. Soc., 1867, p. 909, pl. 44, f. 4.

223—**scabriuscula** Philippi, Cytherea, Abbild. Beschr., ii., 1847, p. 229, pl. 6, f. 2; Angas, Proc. Zool. Soc., 1867, p. 923.

224—**sculpta** Hanley, Proc. Zool. Soc., 1845, p. 11; Reeve, Conch. Icon., vi., 1850, pl. 9, f. 52; Angas, Proc. Zool. Soc., 1867, p. 923.

SUNETTA, Link, Beschr. Rostock Sammlung, 1807, p. 148.

225—**truncata,** Reeve, Meroe, Conch. Icon., xiv., 1864, pl. 2, f. 3.; S. adelinæ, Angas, Proc. Zool. Soc., 1867, p. 909, pl. 54, f. 5.

LIOCONCHA, Morch, Cat. Yoldi, ii., 1853, p. 26.

226—**angasi** Smith, Circe. Chall. Zool., xiii., 1885, p. 148, pl. 2, f. 4.

Sowerby has (Thes. Conch., ii., 1851, p. 643) erroneously recorded Cytherea fastigiata from Sydney.

GAFRARIUM, Bolten, Mus. Bolt., 1798, p. 176.

227—**quoyi** Hanley, Cytherea, Recent Shells, 1844, p. 11, bis, footnote, pl. 15, f. 25; Hedley, P.L.S.N.S.W., xli., 1917, p. 688.

Smith (Chall. Zool., xiii., 1885, p. 141) has erroneously reported Circe scripta, Linn. from Sydney.

MACROCALLISTA, Meek, Pal. Upper Missouri, 1876, p. 179.

228—**disrupta** Sowerby, Cytherea, Thes. Conch., ii., 1853, p. 743, pl. 163, f. 208, 209; Smith, Chall. Zool., xiii., 1885, p. 135, pl. 1, f. 4.

229—**kingii** Gray, Cytherea, King's Survey, ii., 1827, p. 474; Reeve, Dione, Conch. Icon., xiv., 1863, pl. 9, f. 36; C. lamarckii, Hedley, P.L.S.N.S.W., xxv., 1900, p. 498.

PITARIA, Romer, Krit. Unters, 1857, p. 15; Emend, Dall. Trans. Wagner Inst., iii., 1903, p. 1264.

230—**sophiae** Angas, Cytherea, Proc. Zool. Soc., 1877, p. 176, pl. 26, f. 23; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 700.

Pitaria citrina was by Deshayes (Cat. Conchif. Brit. Mus., 1853, p. 72) erroneously cited from Sydney.

ANTIGONA, Schumacher, Essai Nouv. Syst., 1817, p. 51.

231—**chemnitzii** Hanley, Venus, Proc. Zool. Soc., 1844 (1845), p. 160; Reeve, Conch. Icon., xiv., 1863, pl. 10, f. 32.

232—**laqueata** Sowerby, Venus, Thes. Conch., ii., 1853, p. 706, pl. 153, f. 15; Angas, Proc. Zool. Soc., 1867, p. 920.

233—**lamellaris** Schumacher, Essai, 1817, p. 155, pl. 14, f. 1; Brazier, P.L.S.N.S.W., ix., 1884, p. 799.

234—**gallinula** Lamarck, Venus, An. s. vert., v., 1818, p. 592; Delessert, Recueil, 1841, pl. 10, f. 1; Angas, Proc. Zool. Soc., 1877, p. 191.

235—**lagopus** Lamarck, Venus, An. s. vert., v., 1818, p. 591; Hedley, P.L.S.N.S.W., xxvii., 1903, p. 596; C. australis, Angas, Proc. Zool. Soc., 1867, p. 921.

236—**marica** Linné, Venus, Syst. Nat., x., 1758, p. 685; Reeve, Conch. Icon., xiv., 1863, pl. 22, f. 104a (not 104b and c).

237—**scabra** Hanley, Venus, Proc. Zool. Soc., 1844 (1845), p. 161; Reeve, Conch. Icon., xiv., 1863, pl. 21 f. 97.

238—**striatissima** Sowerby, Venus, Thes. Conch., ii., 1853, p. 718, pl. 157, f. 103–5.

CLAUSINELLA, Gray, List British Mollusca, 1851, p. 12.

239—**placida** Philippi, Venus, Abbild. Beschr,, i., 1844, p. 128, pl. 2, f. 2; Hedley, Mem. Austr. Mus., iv., 1902, p. 322; = roborata, Hanley, 1845.

Reeve (Conch. Icon., xiv., 1863, Venus, sp. 112) erroneously reported V. isabellina, from Sydney.

BASSINA, Jukes-Brown, Proc. Malac. Soc., xi., 1914, p. 81.

240—**calophylla** Philippi, Venus, Wiegmann's Archiv., 1., 1836, p. 229, pl. 8, f. 2; Smith, Chall. Zool., xiii., 1885, p. 122.

241—**disjecta** Perry, Venus, Conchology, 1811, pl. 58, f. 3; V. lamellata, Lamarck, 1818.

242—**jacksoni** Smith, Chall. Zool., xiii., 1885, p. 123, pl. 3, f. 2.

243—**paucilamellata** Dunker, Mercenaria, Novit. Conch., i., 1858, p. 52, pl. 16, f. 10–12; Brazier, P.L.S.N.S.W., v., 1880, p. 486; = alatus Reeve, 1863; = Callista victoriæ, Ten. Woods.

GOMPHINA, Morch, Yoldi Cat. ii., 1853, p. 9.

244—**fulgida** Hedley, sp. nov. Distinguished from G. undulosa Lamarck by form and by wider spaced and more jagged color lines. Thes. Conch., ii., 1853, pl. 158, f. 145.

CLEMENTIA, Gray, Proc. Zool. Soc., 1847, p. 184.

245—**crassiplica** Lamarck, Lutraria, An. s. vert., v., 1818, p. 471; C. strangei, Deshayes, Proc. Zool. Soc., 1853 (1854), p. 17; Brazier, P.L.S.N.S.W., xviii., 1894, p. 433.

246—**papyracea** Gray, Venus, Ann. philos. n. ser., ix., 1845, p. 137; Deshayes, Proc. Zool. Soc., 1853 (1854), p. 171, pl. 21, f. 1; V. hyalina, Phil. Abbild. Beschr., iii., 1849, p. 83, pl. 10, f. 6; = V. moretonensis, Deshayes, 1854.

MARCIA, H. & A. Adams, Gen. Rec. Moll., ii., 1857, p. 423.

247—**nitida** Quoy & Gaim., Venus, Astrolabe Zool., iii., 1835, p. 529, pl. 84, f. 13, 14; Hedley, P.L.S.N.S.W., xxix., 1904, p. 194; = fumigata, Sowerby, 1853, = lævigata, Sowerby, 1853.

248—**scalarina** Lamarck, Venus, An. s. vert., v., 1818, p. 599; Delessert, Recueil, 1841, pl. 10, f. 12.

PAPHIA, Bolten, Mus. Bolt., 1798, p. 175.

249—**inflata** Deshayes, Tapes, Proc. Zool. Soc., 1853, p. 8, pl. 19, f. 3; Angas, Proc. Zool. Soc., 1867, p. 923.

250—**semirugata** (Philippi, (Venus), Zeit. Malak., iv., 1847, p. 88; Abbild. Beschr., iii., 1848, p. 76, pl. 7, f. 4; Smith, Chall. Zool., xiii., 1885, p. 115.

251—**textilis** Gmelin, Venus, Syst. Nat., xiii., 1791, p. 3280.

252—**turgida** Lamarck, Venus, An. s. vert., v., 1818, p. 595; Pfeiffer, Conch. Cab., xi., 1870, p. 222, pl. 38, f. 1.

VENERUPIS, Lamarck, An. s. vert., 1818, p. 506.

253—**crenata** Lamarck, An. s. vert., v., 1818, p. 508; Delessert, Recueil, 1841, pl. 5, f. 2; Smith, Zool. Coll. Alert, 1884, p. 97.

254—**fabagella** Deshayes, Tapes, Cat. Conchif. Brit. Mus., 1853, p. 182; Reeve, Conch. Icon., xiv., 1864, pl. 13, f. 66; Smith, Chall. Zool., xiii., 1885, p. 116; Jukes-Browne, Proc. Malac. Soc., xi., 1914, p. 93.

255—**galactites** Lamarck, Venus, An. s. vert., v., 1818, p. 599; Pfeiffer, Conch. Cab., xi., 1870, p. 224, pl. 38, f. 6, 7; Angas, Proc. Zool. Soc., 1877, p. 192.

256—**mitis** Deshayes, Proc. Zool. Soc., 1853 (1854), p. 5; Sowerby, Conch. Icon., xix., 1874, pl. 4, f. 24; Angas, Proc. Zool. Soc., 1867, p. 924.

Family PETRICOLIDÆ.

PETRICOLA, Lamarck, Syst. An. s. vert., 1801, p. 121.

257—**rubiginosa** Adams & Angas, Naranio, Proc. Zool. Soc., 1863, p. 425, pl. 37, f. 17; Brazier, P.L.S.N.S.W., xix., 1895, p. 699.

Family GLAUCONOMYIDÆ.

GLAUCONOMYA, Bronn, Leth. Geogn., 1838, p. 807.

258—**angulata** Reeve, Glauconome, Conch. Icon., ii., 1844, pl. 1., f. 5; Angas, Proc. Zool. Soc., 1867, p. 924.

Family TELLINIDÆ.

TELLINA, Linne, Syst. Nat., x., 1758, p. 674.

259—**albinella** Lamarck, Tellina, An. s. vert., v., 1818, p. 524; var. rosea, Sowerby, Conch. Icon., xvii., 1867, pl. 21, f. 15b; Angas, Proc. Zool. Soc., 1871, p. 100.

260—**astula** Hedley, P.L.S.N.S.W., xli., 1917, p. 691, pl. 52, f. 42, 43.

261—**brazieri** Sowerby, Conch. Icon., xvii., 1869, pl. 55, f. 323.

262—**inæquivalvis** Sowerby, Conch. Icon., xvii., 1867, pl. 26, f. 139.

263—**semitorta** Sowerby, Conch. Icon., xvii., 1867, pl. 39, f. 221.

264—**tenuilirata** Sowerby, Conch. Icon., xvii., 1867, pl. 39, f. 219; Smith, Chall. Zool., xiii., 1885, p. 106.

265—**unifasciata** Sowerby, Conch. Icon., xvii., 1867, pl. 29, f. 156; Lynge, D. Kgl. Danske Vidensk. Selsk. Skrifter, vi., 1909, p. 202.

From Sydney, Tellina perna was erroneously reported by Brazier (P.L.S.N.S.W., ii., 1878, p. 142), and T. ticaonica by Angas (Proc. Zool. Soc., 1867, p. 919).

STRIGILLA, Turton, Dithyr. Brit., 1822, p. 117.

266—**euronia** Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 473, pl. 9, f. 22, 23.

MACOMA, Leach, Ross Voyage, Append. ii., 1819, p. lxii.

267—**lilium** Hanley, Tellina, Proc. Zool. Soc., 1844, p. 147, & Thes. Conch., i., 1846, p. 303, pl. 58, f. 85; Angas, Proc. Zool. Soc., 1867, p. 919.

268—**tortuosa** Sowerby, Tellina, Conch. Icon., xvii., 1867, pl. 39, f. 224.

269—**tristis** Deshayes, Tellina, Proc. Zool. Soc., 1854 (1855), p. 361; ? Thes. Conch., i., 1846, pl. 64, f. 299, as of deltoidalis.

270—**semifossilis** Sowerby, Tellina, Conch. Icon., xvii., 1867, pl. 41, f. 237; ? M. rudis, Bertin, 1878 = M. mariæ, Ten. Woods, 1875, = T. modesta, Tate, 1891.

271—**semiplana** Sowerby, Tellina, Conch. Icon., xvii., 1867, pl. 39, f. 222; Angas, Proc. Zool. Soc., 1867, p. 919.

From New South Wales, Angas (Proc. Zool. Soc., 1867, p. 918) has erroneously recorded Tellina deltoidalis Lamarck.

ARCOPAGIA, Brown, Illustr. Conch. Great Brit., 1827, Explan. pl. 16, f. 8.

272—**striatula** Lamarck, Tellina, An. s. vert., v., 1818, p. 529; Hanley, Thes. Conch., i., 1846, p. 255, pl. 61, f. 175; Brazier, P.L.S.N.S.W., iv., 1886, p. 430.

273—**subelliptica** Sowerby, Tellina, Conch. Icon., xvii., 1867, pl. 39, f. 220; Angas, Proc. Zool. Soc., 1867, p. 918.

PSEUDARCOPAGIA, Bertin, Nouv. Arch. Museum (2), i., 1878, p. 264.

274—**botanica** Hedley, n. sp. Tellina decussata Angas (not Lamarck), Proc. Zool. Soc., 1877, p. 191. Smaller but proportionately longer, more compressed and more delicately sculptured than P. victoriæ Gatliff and Gabriel.

Tellina sulcata (= Arcopagia remies, Linn.) was erroneously reported by Lamarck (An. s. vert., v., 1818, p. 529) from Port Jackson.

Family SEMELIDÆ.

THEORA, Adams, Ann. Nat. Hist., xiii., 1864, p. 206.

275—**lata** Hinds, Neæra, Proc. Zool. Soc., 1843, p. 79; Lamy, Journ. de Conch., lxi., 1913 (1914), p. 299; T. fragilis Hedley, P.L.S.N.S.W., xxvi., 1902, p. 706, pl. 34, f. 4, 5, 6.

276—**pura** Angas, Neæra, Proc. Zool. Soc., 1871, p. 20, pl. 1, f. 30; Lamy, Journ. de Conch., lxi., 1914, p. 263.

ABRA, Lamarck, An. s. vert., v., 1818, p. 492.

277—**elliptica** Sowerby, Tellina, Conch. Icon., xvii., 1867, pl. 39, f. 223; Smith, Zool. Coll. Alert, 1884, p. 99, pl. 7, f. C.

278—**simplex** Sowerby, Tellina, Conch. Icon., xvii., 1867, pl. 41, f. 240; Smith, Zool. Coll. Alert, 1884, p. 99.

Angas erred in recording (Proc. Zool. Soc., 1877, p. 191), Semele scabra Hanley from Sydney.

Family GARIDÆ.

GARI, Schumacher, Essai Nouv. Syst., 1817, p. 44.

279—**anomala** Deshayes, Psammobia, Proc. Zool. Soc., 1854 (1855), p. 320; Reeve, Conch. Icon., x., 1857, pl. 1, f. 5; Smith, Chall. Zool., xiii., 1885, p. 95.

280—**lessoni** Blainville, Psammobia, Dict. Sc. Nat., xliii., 1826, p. 480; Reeve, Conch. Icon., x., 1856, pl. 2, f. 8; Hedley, P.L.S.N.S.W., xxix., 1904, p. 196.

281—**livida** Lamarck, Psammobia, An. s. vert., v., 1818, p. 515; Dautzenberg & Fischer, Journ. de Conch., lxi., 1914, p. 224; pl. 7, f. 4, 5, 6; P. zonalis, Delessert, Recueil, 1841, pl. 5, f. 9; Angas, Proc. Zool. Soc., 1867, p. 917; = radiata, Phillipi, 1845, = tellinæformis, Reeve, 1857; = puella, Deshayes, 1854.

282—**modesta** Deshayes, Psammobia, Proc. Zool. Soc., 1854 (1855), p. 319; Reeve, Conch. Icon., x., 1857, pl. 1, f. 3; Smith, Chall. Zool., xiii., 1885, p. 95.

283—**togata** Deshayes, Psammobia, Proc. Zool. Soc., 1854 (1855), p. 318; Reeve, Conch. Icon., x., 1856, pl. 2, f. 14; Angas, Proc. Zool. Soc., 1867, p. 917.

Psammobia marmorea and palmula were erroneously recorded (Proc. Zool. Soc., 1854, pp. 324, 325) by Deshayes as from Sydney.

SOLETELLINA, Blainville, Dict. Sci. Nat., xxxii., 1824, p. 350.

284—**biradiata** Wood, General Conch., 1815, p. 135, pl. 33, f. 1; Angas, Proc. Zool. Soc., 1867, p. 918.

285—**florida** Gould, Proc. Boston Soc. Nat. Hist., iii., 1850, p. 254, & U.S. Expl. Exped., Moll., xii., 1852, p. 403, f. 513; S. donacioides Reeve, Conch. Icon., x., 1857, pl. 3, f. 11.

ASAPHIS, Modeer, K. Vet. Ac. Nya Handl., xiv., 1793, p. 176.

286—**contraria** Deshayes, Psammobia, Cat. Moll. Reunion, 1863, p. 11, pl. 1, f. 20, 21; Hedley, P.L.S.N.S.W., xxv., 1901, p. 731, pl. 48, f. 4–8.

Family DONACIDÆ.

DONAX, Linné, Syst. Nat., x., 1758, p. 682.

287—**brazieri** Smith, Proc. Zool. Soc., 1891, p. 491, pl. 40, f. 10.

288—**deltoides** Lamarck, An. S. Vert., v., 1818, p. 547; Reeve, Conch. Icon., viii., 1854, pl. 1, f. 4; Hedley, Journ. Roy. Soc. N.S. Wales, xlix., 1915, p. 38, f. 5; = D. epidermia, Lamarck, 1818.

289—**faba** Gmelin, Syst. Nat., xiii., 1791, p. 3264; Roemer, Conch. Cab., x., 1869, p. 88, pl. 2, f. 12–17; D. radians, Angas, Proc. Zool. Soc., 1877, p. 191.

290—**veruinus** Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 274, for nitida Reeve, Conch. Icon., viii., 1854, pl. 6, f. 34, not nitida Lamk., 1806.

From Port Stephens, Bertin has erroneously recorded (Nouv. Archiv. Mus. (2), iv., 1881, p. 82) Donax denticulatus. See also Lamy, Bull. Mus. Hist. Nat., 1914, p. 338.

Family SOLENIDÆ.

SOLEN Linné Syst. Nat., x., 1758, p. 672.

291—**sloanii** Hanley, Cat. Recent Shells, 1842, p. 12, pl. 11, f. 18; Smith, Chall. Zool., xiii., 1885, p. 78.

CULTELLUS, Schumacher, Essai Nouv. Syst., 1817, p. 43.

292—**cultellus** Linné, Solen, Syst. Nat., x., 1758, p. 673; Sowerby, Conch. Icon., xix., 1874, pl. 6, f. 23; C. australis, Angas, Proc. Zool. Soc., 1867, p. 912.

Family MACTRIDÆ.

MACTRA, Linne Syst. Nat., xii., 1767, p. 1125.

293—**contraria** Reeve, Conch. Icon., viii., 1854, pl. 17, f. 86; Deshayes, Proc. Zool. Soc., 1854 (1855), p. 62; Smith, Proc. Malac. Soc., xi., 1914, p. 141.

294—**eximia** Reeve (as of Deshayes, June, 1854), Conch. Icon., viii., April, 1854, pl. 8, f. 31.

295—**jacksoniensis** Smith, Chall. Zool., xiii., 1885, p. 62, pl. 5, f. 9.

296—**ovalina** Lamarck, An. s. vert., v., 1818, p. 477; Delessert, Recueil, 1841, pl. 3, f. 7; Smith, Proc. Malac. Soc., xi., 1914, p. 145.

297—**parkesiana** Hedley, P.L.S.N.S.W., xxvii., 1902, p. 8, pl. 1, f. 5–9.

298—**pusilla** Adams, Proc. Zool. Soc., 1855, p. 226; Smith, Chall. Zool., xiii., 1885, p. 60, pl. 5, f. 8.

Angas erroneously recorded (Proc. Zool. Soc., 1867, p. 916) Trigonella luzonica from Botany Bay.

SPISULA, Gray, Mag. Nat. Hist., i., 1837, p. 372.

299—**trigonella** Lamarck, Mactra, An. s. vert., v., 1818, p. 479; Lamy, Bull. Mus. Hist. Nat., 1914, p. 245; M. parva, Smith, Proc. Malac. Soc., xi., 1914, p. 146.

ANATINA Schumacher, Essai, Nouv. Syst., 1817, p. 42.

300—**meridionalis** Tate, Raeta, Trans. Roy. Soc. S.A., xi., 1889, p. 61, pl. 11, f. 3; Hedley, P.L.S.N.S.W., xxv., 1900, p. 497, pl. 25, f. 5–9.

LUTRARIA, Lamarck, Mem. Soc. Nat. Hist., Paris, 1799, p. 85.

301—**rhynchæna** Jonas, Zeit. f. malak., i., 1844, p. 34; Reeve, Conch. Icon., viii., 1854, pl. 3, f. 16; L. dissimilis, Angas, Proc. Zool. Soc., 1867, p. 917.

STANDELLA, Gray, Ann. Mag. Nat. Hist. (2), xi., 1853, p. 42.

302—**nicobarica** Gmelin, Mactra, Syst. Nat., xiii., 1791, p. 3261; M. ægyptica Reeve, Conch. Icon., viii., 1854, pl. 20, f. 112.

ZENATIA, Gray, Ann. Mag. Nat. Hist. (2), xi., 1853, p. 43.

303—**victoriæ** Pritchard & Gatliff, Proc. Roy. Soc. Vict., xvi., 1903, p. 92, pl. 15, f. 3; Hedley, P.L.S.N.S.W., xxix., 1904, p. 197.

From Botany Bay, Angas (Proc. Zool. Soc., 1867, p. 917) erroneously reported Zenatia acinaces.

Family AMPHIDESMATIDÆ.

AMPHIDESMA, Lamarck, An. s. vert., v., 1818, p. 489.

304—**angusta** Reeve, Mesodesma, Conch. Icon., viii., 1854, pl. 1, f. 3; M. elongata, Deshayes, Proc. Zool. Soc., 1854 (1855), p. 337; Hedley, P.L.S.N.S.W., xli., 1917, p. 692, pl. 46, f. 4.

305—**cuneata** Lamarck, Crassatella, An. s. vert., v., 1818, p. 843; M. obtusa, Crosse & Fischer, Journ. de Conch., xiii., 1865, p. 428, pl. 11, f. 4; Angas, Proc. Zool. Soc., 1867, p. 920; Lamy, Journ. de Conch., lxii., 1914, p. 31, pl. 1, f. 1, 2.

Brazier has noted (Journ. of Conch., ii., 1879, p. 198) that Mesodesma nitida does not occur at Sydney, as stated by Deshayes (Proc. Zool. Soc., 1854, p. 338).

Schmeltz has erroneously reported (Cat. Mus. Godeff., v., 1874, p. 166) Paphia striata from Sydney.

ERVILIA, Turton, Conch. Ins. Brit., 1822, p. 56.

306—**bisculpta** Gould, Proc. Boston Nat. Hist., viii., 1861, p. 28; Hedley, P.L.S.N.S.W., xxxi., 1906, p. 479, pl. 36, f. 8; E. australis, Angas, Proc. Zool. Soc., 1877, p. 175, pl. 26, f. 21.

Family MYACIDÆ.

CRYPTOMYA, Conrad, Philad. Acad. Nat. Sci., iv., 1848, p. 121.

307—**elliptica** Adams, Sphænia, Proc. Zool. Soc., 1850 (1851), p. 88; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 275, pl. 17, f. 40–44.

TURQUETIA, Velain, Archiv. Zool. Exper., vi., 1877, p. 134.

308—**integra** Hedley, Rec. Austr. Mus., vi., 1907, p. 364, pl. 66, f. 7–10.

Family CORBULIDÆ.

CORBULA, Bruguière, Ency. Meth., 1797, Tabl. vers. pl. 230.

309—**smithiana** Brazier, P.L.S.N.S.W., iv., 1879 (1880), p. 388; C. venusta, Angas, Proc. Zool. Soc., 1871, p. 20, pl. 1, f. 29; C. coxi, Pilsbry, Proc. Acad. Nat. Sci. Philad., 1897, p. 363, pl. 9, f. 1–3.

310—**tunicata** Hinds, Proc. Zool. Soc., 1843, p. 55; Reeve, Conch. Icon., ii., 1844, pl. 1, f. 5; Smith, Coll. Alert, 1884, p. 103.

Corbula nasuta and C. zelandica were erroneously recorded from Sydney by Angas, Proc. Zool. Soc., 1867, p. 913.

Family SAXICAVIDÆ.

SAXICAVA, Bellevue, Journ. Phys., liv., 1802, p. 5.

311—**australis** Lamarck, Corbula, An. s. vert., v., 1818, p. 495; Blainville, Man. Malac., 1827, pl. 78, f. 3; Angas, Proc. Zool. Soc., 1867, p. 913.

311a—**australis angasii** Angas, Proc. Zool. Soc., 1865, p. 643; Sowerby, Conch. Icon., xx., 1875, pl. 2, f. 11.

PANOPE, Menard, Mem. Nouv. Genre Coq. Biv., 1807, p. 31.

312—**australis** Sowerby, Genera Shells, 1833, pl. 40, f. 12.

313—**angusta** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 705, pl. 80, f. 40–42.

Family PHOLADIDÆ.

PHOLAS, Linné, Syst. Nat., x., 1758, p. 669.

314—**australasiæ** Sowerby, Thes. Conch., ii., 1849, p. 488, pl. 106, f. 73; Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 473.

315—**obturamentum** Hedley, Rec. Austr. Mus., ii., 1893, p. 55, pl. 14, f. 1–3.

Angas erroneously records (Proc. Zool. Soc., 1871, p. 99) Barnea similis from Sydney Harbour.

MARTESIA, Blainville, Man. Malac., 1825, p. 632.

316—**striata** Linné Pholas, Syst. Nat., x., 1758, p. 669; Sowerby, Thés. Conch., ii., 1849, p. 494, pl. 104, f. 40-42; Hedley, Rep. Austr. Assoc., viii., 1901, p. 249.

JOUANNETIA, Desmoulins, Bull. Linn. Soc. Bordeaux, ii., 1828, p. 244.

317—**cumingii** Sowerby, Triumphalia, Proc. Zool. Soc., 1849 (1850), p. 161; Chenu, Man. Conch., ii., 1862, p. 7, f. 38; Angas, Proc. Zool. Soc., 1877, p. 190.

Family TEREDIDÆ.

NAUSITORIA, Wright, Trans. Linn. Soc., xxiv., 1864, p. 452.

318—**edax** Hedley, Teredo, P.L.S.N.S.W., xix., 1894, p. 501, pl. 32; T. bruguiéri (in part) Gatliff & Gabriel, Proc. Roy. Soc. Vict., xxviii., 1915, p. 118.

319—**saulii** Wright, Trans. Linn. Soc., xxv., 1866, p. 567, pl. 65, f. 9-15; Hedley, P.L.S.N.S.W., xxiii., 1898, p. 94, f. 7–9.

Class CEPHALOPODA. (320 – 341).

Order TETRABRANCHIATA.

Stranded Nautilus pompilius have been recorded from Coff's Harbour by Angas,—Proc. Zool. Soc., 1877, p. 178; from the Bellinger River and Coogee by Brazier, P.L.S.N.S.W., ii., 1877, p. 143; from Curl Curl Lagoon by Hedley, P.L.S.N.S.W., xvii., 1894, p. 239; and from Twofold Bay by Cox, Nautilus, xi., 1897, p. 43.

Stranded Nautilus macromphalus were recorded from Coff's Harbour by Angas, Proc. Zool. Soc., 1877, p. 178.

Order DIBRANCHIATA.

Family SPIRULIDÆ.

SPIRULA, Lamarck, Mem. Soc. N.H., Paris, 1799, p. 80.

320—**spirula** Linné, Nautilus, Syst. Nat., x., 1758, p. 710; Huxley & Pelseneer, Chall. Zool., Pt. lxxxiii., 1895, p. 1-32, pl. 1-6; S. prototypos, Peron Voy. Terr. Aust., Atlas 1804, pl. xxx., fig. 4.

Family SEPIIDÆ.

SEPIA, Linné, Syst. Nat., x., 1758, p. 658.

321—**apama** Gray, Cat. Cephalod., 1849, p. 103; McCoy, Prod. Zool. Vict., Dec. xix., 1888, pl. 188-190.

322—**braggi** Verco, Trans. Roy. Soc. S.A., xxxi., 1907, p. 213, pl. 27, f. 6; Hedley, Rec. Austr. Mus., vii., 1908, p. 134; Chapman, Vict. Nat., xxix., 1912, p. 23, pl. 1.

323—**cultrata** Hoyle, Ann. Mag. Nat. Hist. (5), xvi., 1885, p. 198, and Chall. Zool., xvi., 1887, p. 133, pl. 20.

324—**mestus** Gray, Cat. Cephalop., 1849, p. 108; Hoyle, Chall. Zool., xvi., 1887, p. 123, text fig.

325—**plangon** Gray, Cat. Cephalop., 1849, p. 104; Hoyle, Chall. Zool., xvi., 1887, p. 21.

Family LOLIGINIDÆ.

SEPIOTEUTHIS, Blainville, Dict. Sc. Nat., xxxii., 1824, p. 175.

326—**australis** Quoy & Gaimard, Zool. Astrolabe, ii., 1833, p. 77, pl. 4, f. 1.

LOLIGO, Schneider, Samml. Vern. Abth., 1784, p. 110.

327—**australis** Gray, Cat. Cephalop., 1849, p. 71; Hoyle, Chall. Zool., xvi., 1887, p. 220.

Family SEPIADARIIDÆ.

SEPIOLOIDEA, D'Orbigny, Hist. Ceph., 1839, p. 240.

328—**lineolata** Quoy & Gaimard, Sepiola, Zool. Astrolabe, ii., 1833, p. 82, pl. 5, f. 8, 13.

Family SEPIOLIDÆ.

EUPRYMNA, Steenstrup, Overs. K. Dansk. Vid. Selsk. Fohr., 1887, p. 66.

329—**stenodactyla** Grant, Sepiola, Trans. Zool. Soc., i., 1833, p. 84, pl. ii.; Joubin, Mem. Soc. Zool. France, xv., 1902, p. 92, f. 8, 9; Hoyle, Bull. Mus. Comp. Zool., xliii., 1904, p. 24, f. B, C, D.

Family OMMASTREPHIDÆ.

DOSIDICUS, Steenstrup, Overs. K. Dansk. Vid. Selsk. Fohr., 1857, p. 11.

330—**gigas** D'Orbigny, Ommastrephes, Voy. Amer. Merid., 1835, p. 50, pl. 4; Berry, Bull. Bureau Fish. U.S.A., xxx., 1912, p. 301, pl. 48, 49.

NOTODARUS, Pfeffer, Cephalop. Plankton Exped. Humboldt-Stift, 1912, p. 223.

331—**gouldi** McCoy, Ommastrephes, Prod. Zool. Vict., 1880, p. 227, pls. 169-170; Berry, Endeavour Biological Results (in the press).

Family ONYCHOTEUTHIDÆ.

ONYCHOTEUTHIS, Lichtenstein, Isis, 1818, p. 1591.

332—**rutilus** Gould, Am. Expl. Exped., Moll., xii., 1852, p. 482, pl. 50, f. 595.

GALITEUTHIS, Joubin, Ann. Sci. Nat. Zool. (8), vi., 1898, p. 279.

333—**suhmii** Hoyle, Taonius, Narr. Chall. Exped., 1885, p. 472, f. 173-4; Chun, Wiss. Erg. Valdivia, xviii., Cephalopoda, 1910, p. 382, pl. lix.

Family POLYPODIDÆ.

POLYPUS, Schneider, Samml. verm. Ah., 1784, p. 116.

334—**australis** Hoyle, Octopus, Chall. Zool., xvi., 1886, p. 88, pl. 3, f. 45; Massy, Cephalopoda Terra-Nova Exped., 1916, p. 149, f. 9, 10.

335—**cyaneus** Gray, Octopus, Cat. Cephalop, 1849, p. 15; Hoyle, Chall. Zool., xvi., 1886, p. 12.

336—**duplex** Hoyle, Octopus, Chall. Zool., xvi., 1886, p. 90, pl. 7, f. 5.

337—**maculosus** Hoyle, Octopus, Proc. Roy. Phys. Soc. Edinb., vii., 1883, p. 319, pl. 6; Smith, Alert Zool., 1884, p. 36, pl. 4, f. C.; Saville Kent, Great Barrier Reef, 1893, p. 362, pl. 13, f. 3; O. pictus, Brock (not Verrill), Zeit. wiss. Zool. xxxvi., 1882, p. 603, pl. 37, f. 3.

338—**robustus** Brock, Octopus, Nachr. Ges. Gotting, 1887, p. 317.

339—**tetricus** Gould, Octopus, Am. Expl. Exped., xii., 1852, Moll., p. 474, pl. 47, f. 588; O. boscii var. pallida Hoyle, Chall. Zool., xvi., 1886, p. 81, pl. 1, 2.

Family ARGONAUTIDÆ.

ARGONAUTA, Linné, Syst. Nat., x., 1758, p. 708.

340—**grandiformis** Perry, Conchology, 1811, pl. 42, f. 4; Dall, Bull Mus. Comp. Zool., xliii., 1906, p. 227.

341—**nodosa** Solander, Portland Cat. 1786, p. 96 for Rumphius Rareit, Amb., pl. xviii., f. 1; Prince, P.L.S.N.S.W., x., 1886, p. 448.

Argonauta crassicosta (=A. hians Solander, fide Dall, Bull. Mus. Comp. Zool., xliii., 1906, p. 229), Blainville, Dict. Sci. Nat., xliii., 1826, p. 213, is apparently recorded from Port Jackson by Oken, Isis, No. 9, 1823, p. 459, pl. 16, figs. 1–2.

Class AMPHINEURA. (342 - 372).

Order POLYPLACOPHORA.

Family LEPIDOPLEURIDÆ.

LEPIDOPLEURUS, Risso, Hist. Nat. Europe merid., iv., 1826, p. 267.

342—**badius** Hedley & Hull, Rec. Austr. Mus., vii., 1909, p. 260, pl. 73, f. 1, 2.

CHORIPLAX, Pilsbry, Nautilus, vii., 1894, p. 139.

343—**grayi** Adams & Angas, Microplax, Proc. Zool. Soc., 1864, p. 194, 1865, pl. 11, f. 16; Pilsbry, Man. Conch., xiv., p. 21, pl. 6, f. 9, 10, 11.

Family ISCHNOCHITONIDÆ.

CALLOCHITON, Gray, Proc. Zool. Soc., 1847, p. 126.

344—**platessa** Gould, Chiton, Proc. Boston. Soc. Nat. Hist., ii, 1846, p. 143, and U.S. Expl. Exped., xii., 1852, p. 320, pl. 28, f. 434.

From N.S. Wales, Reeve has erroneously recorded (Conch. Icon., iv., 1847, Chiton, pl. 22, f. 148) a Peruvian species Chiton dieffenbachii.

ISCHNOCHITON, Gray, Proc. Zool. Soc., 1847, p. 126.

345—**australis** Sowerby, Chiton, Mag. Nat. Hist., iv., 1840, p. 290; Reeve Conch. Icon., iv., 1847, pl. 2, f. 10.

346—**crispus** Reeve, Chiton, Conch. Icon., iv., 1847, pl. 19, f. 120; Pilsbry, Proc. Ac. Nat. Sci. Philadel., 1894, p. 72.

347—**fruticosus** Gould, Chiton, Proc. Boston Soc. Nat. Hist., ii., 1846, p. 142, and U.S. Expl. Exped., xii., 1852, Moll., p. 319, pl. 28, f. 428.

348—**lentiginosus** Sowerby, Chiton, Mag. Nat. Hist., iv., 1840, p. 293; Reeve. Conch. Icon., iv., 1847, pl. 24, f. 165; Pilsbry, Proc. Acad. Nat. Sci., Philadel., 1894, p. 73.

349—**proteus** Reeve, Chiton, Conch. Icon., iv., 1847, pl. 8, f. 11; C. divergens, Reeve, op. cit. pl. 18, f. 44.

350—**smaragdinus** Angas, Lophyrus, Proc. Zool. Soc., 1867, p. 115, pl. 13, f. 28; var. **picturatus,** Pilsbry, Proc. Ac. Nat. Sci., Philad., 1894, p. 72.

Angas has erroneously recorded (Proc. Zool. Soc., 1867, p. 222) Ischnochiton ustulatus, from Watson's Bay.

CALLISTOCHITON, Dall, U.S. Nat. Museum, 1881 (1882), p. 283.

351—**antiquus** Reeve, Chiton, Conch. Icon., iv., 1847, pl. 25, f. 169.

Family MOPALIIDÆ.

PLAXIPHORA, Gray, Proc. Zool. Soc., 1847, pp. 65 & 169.

352—**albida** Blainville, Chiton, Dict. Sci. Nat., xxxi., 1825, p. 547; Iredale, P. Malac. Soc., ix., p. 98; P. petholata, Angas, Proc. Zool. Soc., 1867, p. 224.

353—**paeteliana** Thiele, Zool. Chun., 1909, heft. 56, p. 26, pl. 3, f. 34–36.

Iredale indicates (P. Malac. Soc., ix., 1910, p. 93) that Plaxiphora egregia was erroneously credited to Newcastle, N.S. Wales, by H. Adams, Proc. Zool. Soc., 1866, p. 445, whereas it is a native of New Zealand.

Family CRYPTOCONCHIDÆ.

ACANTHOCHITONA, Gray, London Medical Repository, xv., 1821, p. 234.

354—**costata** Adams & Angas, Acanthochites, Proc. Zool. Soc., 1864, p. 194; Smith, Zool. Coll. Alert, 1884, p. 83, pl. 6, f. F.

355—**coxi** Pilsbry, Acanthochites, Proc. Acad. Philad., 1894, p. 80, pl. 3, f. 21, 26, pl. 4, f. 34.

356—**granostriata** Pilsbry, Acanthochites, Proc. Acad. Philad., 1894, p. 81, pl. 2, f. 1–6, pl. 4, f. 37.

357—**maughani** Torr & Ashby, Acanthochites, Trans. Roy. Soc. S.A., xxii., 1898, p. 218, pl. 7, f. 5; Hedley & Hull, Rec. Austr. Mus., vii., 1909, p. 265, pl. 74, f. 24–27.

358—**retrojecta** Pilsbry, Acanthochites, Proc. Acad. Philad., 1894, p. 78, pl. 2, f. 12–14.

359—**variabilis** Adams & Angas, Hanleya, Proc. Zool. Soc., 1864, p. 194; Hedley & Hull, Rec. Austr. Mus., vii., 1909, p. 266; Thiele, Zoologia, xxii., 1910, p. 72, pl. 7, f. 9–10.

360—**wilsoni** Sykes, Acanthochites, Proc. Malac. Soc., ii., 1896, p. 92, pl. 6, f. 2; Hedley & Hull, Rec. Austr. Mus., vii., 1909, p. 265; Torr, Trans. Roy. Soc. S.A., xxxvi., 1912, p. 162.

Iredale (Proc. Malac. Soc., ix., 1910, p. 101) eliminated Acanthochites carinatus from the Australian fauna as being identical with the European A. discrepans.

From Watson's Bay, Angas (Proc. Zool. Soc., 1867, p. 224) has incorrectly cited Acanthocites scutiger.

CRYPTOPLAX, Blainville, Dict. Sci. Nat., xii., 1818, p. 124.

361—**striatus** Lamarck, Chitonellus, An. s. vert., vi., 1819, p. 317; Pilsbry, Proc. Malac. Soc., iv., 1901, p. 153, pl. 15, f. 20–23.

Family CHITONIDÆ.

RHYSSOPLAX, Thiele, Das Gebiss Schnecken, ii., 1893, p. 368.

362—**coxi** Pilsbry, Chiton, Proc. Acad. Philad., 1894, p. 85; Hedley & Hull, Rec. Austr. Mus., vii., 1909, p. 262, pl. 73, f. 3–5; C. bellulus Thiele, Zoologica, heft. 56, 1910, p. 93, pl. 10, f. 5–8.

363—**jugosus** Gould, Chiton, Proc. Boston Soc. Nat. Hist., ii., 1846, p. 142, and Am. Expl. Exped., xii., 1852, Moll., p. 317, pl. 28, f. 430.

364—**limans** Sykes, Chiton, Proc. Malac. Soc., ii., 1896, p. 93; C. muricatus, Adams, Proc. Zool. Soc., 1852 (1854), p. 91, pl. 16, f. 6.

365—**translucens** Hedley & Hull, Rec. Austr. Mus., vii., 1909, p. 263, pl. 74, f. 14–18.

366—**vauclusensis** Hedley & Hull, op. cit., p. 261, pl. 74, f. 19–23.

SYPHAROCHITON, Thiele, Gebiss, Schnecken, ii., 1893, p. 365.

367—**pellis-serpentis** Quoy & Gaimard, Chiton, Zool. Astrolabe, iii., 1835, p. 381, pl. 74, f. 17–22; Pilsbry, Proc. Acad. Philad., 1894, p. 85.

TONICIA, Gray, Proc. Zool. Soc., 1847, pp. 65, 168.

368—**carpenteri** Angas, Proc. Zool. Soc., 1867, p. 116, pl. 13, f. 30.

Tapparone Canefri has erroneously recorded (Zool. Magenta, 1873, p. 181) Acanthopleura peruviana as from Sydney.

LIOLOPHURA, Pilsbry, Nautilus, vi., 1903, p. 105.

369—**gaimardi** Blainville, Chiton, Dict. Sci. Nat., xxxvi., 1825, p. 546; Nierstrasse, Notes Leyden Museum, xxv., 1905, p. 154, pl. 10, f. 20, 21.

LORICA, H. & A. Adams, Ann. Nat. Hist. (2), ix., 1852, p. 355.

370—**volvox** Reeve, Chiton, Conch. Icon., iv., 1847, pl. vi., f. 31; Hull, P.L.S.N.S.W., xxxv., 1910, p. 655, pl. 17, f. 2.

LORICELLA, Pilsbry, Man. Conch. xvi., 1903, p. 238.

371—**angasi** H. Adams, Lorica, Proc. Zool. Soc., 1864, p. 193; Thiele, Zoologica, heft. 56, 1910, p. 88, pl. 9, f. 22–25.

ONITHOCHITON, Gray, Proc. Zool. Soc., 1847, pp. 65, 169.

372—**quercinus** Gould, Chiton, Proc. Boston Soc. Nat. Hist., ii., 1846, p. 142, and U.S. Expl. Exped., xii., 1852, Moll., p. 312, pl. 28, f. 437; Iredale, Proc. Malac. Soc., ix., 1910, p. 104.

Dr. J. Thiele has described (Zool. Chun, 1909, heft. 56, p. 99, pl. 10, f. 60–61) Onithochiton scholvini as from New South Wales, but really it belongs to West Australia. A Pitcairn Island species, Onithochiton lyellii, has been erroneously quoted by Nierstrasse (Notes from Leyden Museum, xxv., 1905, p. 156) as from Sydney.

Class GASTEROPODA. (373 – 1201).

Order DIOTOCARDIA. (373 – 488)

Family PLEUROTOMARIIDÆ.

SCISSURELLA, D'Orbigny, Mem. Soc. Hist. Nat., Paris, 1823, p. 340.

373—**australis** Hedley, Mem. Austr. Mus., iv., 1903, p. 329, f. 63.

Scissurella crispata has been erroneously recorded from N.S. Wales by Smith (Proc. Malac. Soc., i., 1894, p. 60).

SCHISMOPE, Jeffreys, Ann. Mag. Nat. Hist., xvii., 1856, p. 321.

374—**atkinsoni** Ten. Woods, Scissurella, Proc. Roy. Soc. Tasm., 1876 (1877), p. 149; S. carinata, Watson, Chall. Zool. xv., 1886, p. 119, pl. 8, f. 6 (not S. carinata, A. Adams, 1862).

375—**beddomei** Petterd, Journ. of Conch., iv., 1884, p. 139; Tate & May, P.L.S.N.S.W., xxvi., 1901, p. 407, pl. 24, f. 24.

Family FISSURELLIDÆ.

SCUTUS, Montfort, Conch. Syst., ii., 1810, p. 58.

376—**antipodes** Montfort, op. cit., Hedley, P.L.S.N.S.W., xli., 1917, p. 704, pl. 47, f. 7, 8, 9.

TUGALIA, Gray (emend.), Dieffenbach's New Zealand, ii., 1843, p. 240.

377—**parmophoidea**, Quoy & Gaimard, Emarginula, Zool. Astrolabe, iii., 1834, p. 325, pl. 68, f. 15, 16; Hedley, P.L.S.N.S.W., xli., 1917, p. 697, pl. 52, f. 45.

HEMITOMA, Swainson, Malac., 1840, p. 356.

378—**aspera** Gould, Emarginula, Proc. Boston Soc. Nat. Hist., ii., 1846, p. 154; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 708, pl. 77, f. 4, and xli. 1917, p. 699, pl. 46, f. 6; E. radiata, Gould, op. cit., vii., 1859, p. 163.

EMARGINULA, Lamarck, Syst. An. s. vert., 1801, p. 69.

379—**bajula** Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 276, for E. dilecta Hedley (not Adams), op. cit., xxx., 1906, p. 521, pl. xxxiii., f. 37, 38.

380—**candida** Adams, Proc. Zool. Soc., 1851 (1852), p. 85; Thes. Conch., iii., 1863, p. 213, pl. 246, f. 45, 46; Angas, Proc. Zool. Soc., 1877, p. 189.

381—**superba** Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 216, pl. 37, f. 7, 8.

MEGATEBENNUS, Pilsbry, Man. Conch., xii., 1890, p. 182.

382—**concatenatus** Crosse & Fischer, Fissurella, Journ. de Conch., xii., 1864, p. 348, and xiii., 1865, p. 41, pl. 3, f. 1–3; Angas, Proc. Zool. Soc., 1867, p. 218.

383—**javanicensis** Lamarck, Fissurella, An., s. vert., vi., 1822, p. 14; Delessert, Recueil, 1841, pl. 24, f. 8; F. scutella Angas, Proc. Zool, Soc., 1867, p. 219.

LUCAPINELLA, Pilsbry, Man. Conch., xii., 1890, p. 179.

384—**nigrita** Sowerby, Fissurella, Proc. Zool. Soc., 1834 (1835), p. 127; Hedley, P.L.S.N.S.W., xli., 1917, p. 706, pl. 47, f. 10; Not F. nigrita, Jay, 1839.

DIODORA, Gray, London Medical Repository, xv., 1821, p. 383.

385—**lineata** Sowerby, Fissurella, Conch. Ill., 1835, p. 7, pl. 78, f. 68; Hedley, P.L.S.N.S.W., xxv., 1900, p. 95, pl. 3, f. 11.

386—**watsoni** Brazier, Glyphis, P.L.S.N.S.W., xix., 1894, p. 177, pl. 14, f. 15.

ZEIDORA, Adams, Ann. Mag. Nat. Hist. (3), v., 1860, p. 301.

387—**lodderæ** Tate & May, Trans. Roy. Soc. S.A., xxiv., 1900, p. 101; Z. tasmanica Hedley, P.L.S.N.S.W., xxv., 1900, p. 93, text fig.

PUNCTURELLA, Lowe, Zool. Journ., iii., 1827, p. 77.

388—**demissa** Hedley, Rec. Austr. Mus., v., 1904, p. 93, f. 19, and vi., 1907, p. 289, pl. 54, f. 3–5.

389—**harrissoni** Beddome, Cemori, Proc. Roy. Soc. Tasm., 1882 (1883), p. 168; P. henniana, Brazier, P.L.S.N.S.W., xix., 1894, p. 177, pl. 14, f. 14.

390—**kesteveni** Hedley, P.L.S.N.S.W., xxv., 1900, p. 499, pl. 25, f. 15–17.

Family HALIOTIDÆ.

HALIOTIS, Linné, Syst. Nat., x., 1758, p. 779.

391—**brazieri,** Angas, Proc. Zool. Soc., 1869, p. 45, pl. 2, f. 1.

392—**cocoradiatum** Reeve, Conch. Icon., iii., 1846, pl. 13, f. 46; Angas, Proc. Zool. Soc., 1867, p. 218.

393—**hargravesi,** Cox, Proc. Zool. Soc., 1869, p. 49, pl. 26, f. 4; Hedley, P.L.S.N.S.W., xxx., 1906, p. 520.

394—**nævosum** Martyn, Univ. Conch., 1784, pl. 63; Angas, Proc. Zool. Soc., 1867, p. 218.

In error, Brazier has recorded (P.L.S.N.S.W., ii., 1877, 142, p. 370), Haliotis parva from Sydney.

Family STOMATIDÆ.

STOMATELLA, Lamarck, An. S. vert., vi., 1819, p. 209.

395—**imbricata** Lamarck, Encycl. Meth., 1816, p. 10, pl. 450, f. 2 and An. s. vert., vi., 1819, p. 209; Angas, Proc. Zool. Soc., 1867, p. 218.

GENA, Gray, Proc. Zool, Soc., 1847, p. 146.

396—**strigosa** Adams, Proc. Zool, Soc., 1850, p. 37; Pilsbry, Man. Conch., xii., 1890, p. 39, pl. 35, f. 31, 32; Hedley, P.L.S.N.S.W., xli., 1917, p. 703, pl. 47, f. 11.

Angas incorrectly referred (Proc. Zool. Soc. 1865, p. 183), Gena auricula, Lamarck to Port Jackson.

ROYA, Iredale, Proc. Malac. Soc., x., 1912, p. 218.

397—**nutata** Hedley, Capulus, P.L.S.N.S.W., xxxiii., 1908, p. 467, pl. 9, f. 15, 16.

Family TROCHIDÆ.

CLANCULUS, Montfort, Conch. Syst., ii., 1810, p. 190.

398—**albugo** Watson, Trochus, Chall. Zool., xv., 1886, p. 75, pl. 6, f. 8.

399—**aloysii** Ten. Woods, Proc. Zool. Soc., Tasm., 1875, p. 155; Pilsbry Man. Conch., xi., 1889, p. 59, pl. 14, f. 20–23; Hedley, P.L.S.N.S.W., xli., 1917, p. 700.

400—**clangulus** Wood, Trochus, Index Test. suppl., 1828, pl. 5, f. 31; Brazier, Journ. of Conch., vi., 1889, p. 74.

401—**floridus** Philippi, Trochus, Zeit. Malak., vi., 1849, p. 156 and Conch. Cab., n.s., ii., 1851, p. 243, pl. 36, f., 15; C. gibbosus, Angas, Proc. Zool. Soc., 1867, p. 215.

402—**maugeri** Wood, Trochus, Index Test. suppl., 1828, p. 220, pl. 5, f. 27a; Angas, Proc. Zool. Soc., 1867, p. 214.

403—**omalomphalus** Adams, Proc. Zool. Soc., 1851 (1853), p. 162; Fischer, Coq. Viv., 1877, p. 235, pl. 81, f. 2.

404—**plebejus** Philippi, Trochus, Zeit Malak., viii., 1851, p. 41 and Conch. Cab. n.s., ii., 1855, p. 326, pl. 46, f. 10; Pritchard & Gatliff, Proc. Roy. Soc. Vict., xiv., 1902. p. 122.

405—**undatus** Lamarck, Monodonta, Encycl. Meth. vers, 1816, p. 10, pl. 447, f. 3; Chenu, Man. Conch., i., 1859, p. 357, f. 2648; Angas, Proc. Zool. Soc., 1877, p. 138.

406—**undatoides** Ten. Woods, Clanculus, P.L.S.N.S.W., iv., 1879, p. 22, pl. 4, f. 7.

Gould (Proc. Bost. Soc. Nat. Hist., viii., 1861, p. 14), erroneously assigned Clanculus jucundus to Sydney.

Angas (Proc. Zool. Soc., 1867, p. 214), erroneously cited C. clanguloides from Watson's Bay.

Tapparone Canefri (Zool. Magenta, 1873, p. 161, pl. 1, f. 11), erroneously ascribed C. variegatus to Sydney.

Perry (Arcana, 1810, pl. 2, f. 4), erroneously quoted Trochus apiaria from Botany Bay. In his Conchology, 1811, pl. 47, f. 3, this name is changed to T. altus Perry, which is referred by Fischer to Trochus conus, Gmelin.

EURYTROCHUS, Fischer, Coq. Viv., Trochus, 1880, p. 417.

407—**strangei** Adams, Monodonta, Proc. Zool. Soc., 1851 (1853), p. 177; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 709, pl. 81, f. 45; G. dacostana, Preston, Proc. Malac. Soc., viii., 1909, p. 377.

CANTHARIDUS, Montfort, Syst. Conch., ii., 1810, p. 251.

408—**eximius** Perry, Bulimus, Conchology, 1811, pl. 30, f. 2; Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 465.

409—**fasciatus** Menke, Phasianella, Synop. Meth. Moll., 1830, p. 141; Pilsbry, Man. Conch., xi., 1889, p. 135, pl. 40, f. 28–33.

410—**lineolaris** Gould Cantharidus, Proc. Boston. Soc. Nat. Hist., viii., 1861, p. 14; Bankivia picturata Smith, Zool. Coll. Alert, 1884, p. 75, pl. 6, f. C.; Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 466.

Angas erroneously reported (Proc. Zool. Soc., 1867, p. 216), Elenchus leucostigma, Menke from Port Jackson.

MONODONTA, Lamarck, Mem. Soc. N.H., Paris, 1799, p. 74.

411—**concamerata** Wood, Trochus, Index Test., suppl., 1828, pl. 6, f. 35; Trochus striolatus, Quoy & Gaimard, Zool. Astrolabe, iii., 1834, p. 253, pl. 63, f. 18–22; T. fuligineus, Chall. Zool., xv., 1886, p. 67, pl. 4, f. 11.

412—**obtusa** Dillwyn, Trochus, Descrip. Cat., ii., 1817, p. 809; Hedley, P.L.S.N.S.W., xli., 1917, p. 700, pl. 47, f. 12; = M. zebra, Menke, 1828; = T. taeniatus, Quoy & Gaimard, 1834; = T. multicarinata, Chenu, 1859.

412a—**obtusa porcata**, A. Adams, Labio, Proc. Zool. Soc. 1851 (1853), p. 177; Trochus extenuatus, Fischer, Coq. Viv., 1878, p. 330, pl. 103, fig. 1.

CANTHARIDELLA, Pilsbry, Manual Conch., xi., 1889, p. 197.

413—**picturata** Adams & Angas, Gibbula, Proc. Zool. Soc., 1864, p. 36; Fischer, Coq. Viv., 1878, p. 283, pl. 90, f. 2.

414—**tiberiana** Crosse, Trochus, Journ. de Conch., xi., 1863, p. 381, pl. 13, f. 2; Angas, Proc. Zool. Soc., 1867, p. 215.

CALLIOTROCHUS, Fischer, Coq. Viv., Trochus, 1880, p. 418.

415—**coxi** Angas, Gibbula, Proc. Zool. Soc., 1867, p. 115, pl. 13, f. 26; Fischer, Coq. Viv., 1879, p. 339, pl. 105, f. 3.

416—**tasmanicus** Petterd, Journ. of Conch., ii., 1879, p. 103; Pilsbry, Man. Conch., xi., 1889, p. 237, pl. 40, f. 20.

In error, Angas (Proc. Zool. Soc., 1867, p. 217), listed Gibbula sulcosa from New South Wales; vide Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 478.

FOSSARINA, Adams & Angas, Proc. Zool. Soc., 1863, p. 423.

417—**patula** Adams & Angas, op. cit., p. 425, pl. 37, f. 9, 10; F. brazieri Angas, Proc. Zool. Soc., 1871, p. 18, pl. 1, f. 24; Kesteven, Rec. Austr. Mus., iv., 1902, p. 318.

MONILEA, Swainson, Malacology, 1840, p. 352.

418—**angulata** Adams, Margarita, Proc. Zool. Soc., 1851 (1853), p. 190; T. prodictus, Fischer, Coq. Viv., 1879, p. 395, pl. 118, f. 1; M. apicina Gould, Proc. Boston Soc. Nat. Hist., viii., 1861, p. 14; Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 464.

419—**lentiginosa** Adams, Proc. Zool. Soc., 1851 (1853), p. 188; Fischer, Coq. Viv., 1878, p. 317, pl. 100, f. 1.

420—**oleacea** Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 215, pl. 37, f. 1.

421—**vitiliginea** Menke, Trochus, Moll. Nov. Holl. Spm., 1843, p. 18; Philippi, Conch. Cab., n.s., ii., 1851, p. 176, pl. 28, f. 2; Watson, Chall. Zool., xv., 1886, p. 72.

MINOLIA, Adams, Ann. Mag. Nat. Hist. (3), vi., 1860, p. 336.

422—**arata** Hedley, Mem. Austr. Mus., iv., 1903, p. 333, f. 65.

423—**bellula** Angas, Proc. Zool. Soc., 1869, p. 48, pl. 2, f. 11; T. dianthus, Fischer, 1879.

424—**philippensis,** Watson, Trochus, Jour. Linn. Soc., xv., 1881, p. 92 and Chall. Zool. xv., 1886, p. 73, pl. 6, f. 10.

425—**pulcherrima** Angas, Proc. Zool. Soc., 1869, p. 48, pl. 2, f. 10.

426—**rosulenta,** Watson, Solarium, Chall. Zool. xv., 1886, p. 136, pl. 8, f. 12; Hedley, Mem. Austr. Mus., iv., 1903, p. 332.

CALLIOSTOMA, Swainson, Malacology, 1840, p. 351.

427—**armillatum** Wood, Trochus, Index, Test, suppl., 1828, pl. 9, f. 5. Angas, Proc. Zool. Soc., 1877, p. 188.

428—**comptum** Adams, Ziziphinus, Proc. Zool. Soc., 1854 (1855), p. 38; C. purpureocinctum Hedley, P.L.S.N.S.W., xix., 1894, p. 35, text fig., and xxxviii., 1913, p. 279.

429—**decoratum** Phillipi, Trochus, Zeit. Malac., iii., 1846, p. 102 and Conch. Cab., n.s., ii., 1851, p. 59, pl. 13, f. 1; Hedley, P.L.S.N.S.W., xxvi., 1901, p. 19.

430—**speciosum** Adams, Ziziphinus, Proc. Zool. Soc., 1854 (1855), p. 38; Reeve, Conch. Icon., xiv., 1863, pl. 2, f. 9; Angas, Proc. Zool. Soc., 1877, p. 188.

ASTELE, Swainson, Proc. Roy. Soc., V.D. Land., iii., 1854, p. 38.

431—**scitulus** Adams, Ziziphinus, Proc. Zool. Soc., 1854 (1855), p. 38; Reeve, Conch. Icon., xiv., 1863, pl. 6, f. 44; Angas, Proc. Zool. Soc., 1867, p. 215.

SOLARIELLOPSIS, Schepman, Siboga, Exped. Zool., xlixa., 1908, pp. 53 and 452.

432—**glyptus** Watson, Trochus, Journ. Linn. Soc., xiv., 1879, p. 694; Chall. Zool., xv., 1886, p. 75, pl. 6, f. 6; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 709.

BASILLISA, Watson, Journ. Linn. Soc., xiv., 1879, p. 593.

433—**radialis,** Tate var. bilix, Hedley, Rec. Austr. Mus., vi., 1905, p. 48, f. 13; Verco, Trans. Roy. Soc. S.A., xxx., 1906, p. 218, pl. 10, f. 1–3.

EUCHELUS, Philippi, Zeit. Malac., iv., 1847, p. 20.

434—**baccatus** Menke, Monodonta, Moll. Nov. Holl. Spm., 1843, p. 14; Philippi, Conch. Cab., n.s., ii., 1851, p. 173, pl. 27, f. 13; Angas, Proc. Zool. Soc., 1867, p. 215.

435—**scabriusculus** Adams & Angas, Proc. Zool. Soc., 1867, p. 215; Fischer, Coq. Viv., 1879, p. 374, pl. 114, f. 2.

TALLORBIS, G. & H. Nevill, Journ. Asiat. Soc. Bengal, xxxviii., 1869, p. 159.

436—**ampullus** Tate, Euchelus, Trans. Roy. Soc. S.A., xvii., 1893, p. 197, pl. 1, f. 5; Hedley, P.L.S.-N.S.W., xxxix., 1915, p. 709.

Family TURBINIDÆ.

PHASIANELLA, Lamarck, Ann. Mus., iv., 1804, p. 295.

437—**perdix** Wood, Index Test. suppl., 1828, p. 48, pl. 6, f. 46; E. ventricosa, Angas, Proc. Zool. Soc., 1867, p. 212.

438—**rosea** Angas, Eutropia, Proc. Zool. Soc., 1867, p. 114, pl. 13, f. 24.

439—**virgo** Angas, Eutropia, Proc. Zool. Soc., 1867, p. 115, pl. 13, f. 25.

From Port Jackson, Angas has erroneously cited (Proc. Zool. Soc., 1867, p. 213), Phasianella kochii Philippi.

From Sydney, Gould (Proc. Boston Soc. Nat. Hist., viii., 1861, p. 18), mis-reported Elenchus exiguus, vide Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 278.

TURBO, Linné Syst. Nat., x., 1758, p. 761.

440—**exquisitus** Angas, Proc. Zool. Soc., 1877, p. 175, pl. 26, f. 18; Hedley, P.L.S.N.S.W., xxvi., 1902, p. 701, pl. 34, f. 7.

441—**militaris** Reeve, Conch. Icon., iv., 1848, pl. 9, f. 40; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 282.

441a—**petholatus,** Linné, Syst. Nat. x., 1758, p. 762; Angas, Proc. Zool. Soc., 1877, p. 188.

442—**stamineus** Martyn, Limax, Univ. Conch., 1784, f. 71; Watson, Chall. Zool., xv., 1886, p. 127.

443—**undulatus** Martyn, Limax, Univ. Conch., 1784, f. 29; Brazier, P.L.S.N.S.W., xviii., 1893, p. 112.

In error, Angas (Proc. Zool. Soc., 1871, p. 96) recorded Turbo imperialis from Watson's Bay. Brazier has also recorded (P.L.S.N.S.W., iv., 1880, p. 429) T. squamosus from the North Head.

ASTRÆA, Bolten, Mus. Bolt, 1798, p. 79.

444—**fimbriata** Lamarck, Trochus, An. s. vert., vii., 1822, p. 12; Kesteven, P.L.S.N.S.W., xxvii., 1902, p. 2, text fig.

445—**tentoriiformis** Jonas, Trochus, Zeit. Malak., ii., 1845, p. 66; Kesteven, P.L.S.N.S.W., xxvii., 1902, p. 3, fig.; = T. sirius, Gould, 1849.

Family LIOTIIDÆ.

CALLOMPHALA, Adams & Angas, Proc. Zool. Soc., 1864, p. 35.

446—**lucida** Adams & Angas, op. cit,. p. 35; Hedley, P.L.S.N.S.W., xxiv., 1899, p. 434, f. 5.

447—**brazieri** Angas, Ethalia, Proc. Zool. Soc., 1877, p. 39, pl. 5, f. 17.

TEINOSTOMA, H. & A. Adams, Proc. Zool. Soc., 1853 (1855), p. 183.

448—**starkeyæ** Hedley, P.L.S.N.S.W., xxiv., 1899, p. 433, f. 4.

CIRSONELLA, Angas, Proc. Zool. Soc., 1877, p. 38.

449—**weldii** Ten. Woods, Cyclostrema, Proc. Zool. Soc. Tasm. 1876 (Feb. 27, 1877), p. 147; C. australis Angas, Proc. Zool. Soc., 1877 (June 1, 1877), p. 38, pl. 5, f. 16; Tate & May, P.L.S.N.S.W., xxvi., 1901, p. 397, f. 8.

BROOKULA, Iredale, Proc. Malac. Soc., x., 1912, p. 219.

450—**angeli** Ten. Woods, Rissoa, Proc. Roy. Soc. Tasm., 1876 (1877), p. 153; Hedley, P.L.S.N.S.W., xxv., 1900, p. 503, pl. 25, f. 14.

451—**crebrisculpta** Tate, Cyclostrema, Trans. Roy. Soc. S.A., xxiii., 1899, p. 219, pl. 7, f. 5.

LISSOTESTA, Iredale, Trans. N.Z. Inst., xlvii., 1914 (1915), p. 442.

452—**charopa** Tate, Cyclostrema, Trans. Roy. Soc. S.A., xxiii., 1899, p. 217, pl. 7, f. 2; Hedley, P.L.S.-N.S.W., xxv., 1901, p. 722.

453—**inscripta** Tate, Cyclostrema, Trans. Roy. Soc. S.A., xxiii., 1899, p. 216, pl. 7, f. 3; Hedley, Mem. Austr. Mus., iv., 1903, p. 337, f. 67.

454—**micra** Ten. Woods, Cyclostrema, Proc. Roy. Soc. Tasm., 1876 (1877), p. 147; Tate & May, P.L.S.N.S.W., xxvi., 1901, p. 397, pl. 27, f. 91.

455—**porcellana** Tate & May, Cyclostrema, Trans. Roy. Soc. S.A., xxiv., 1900, p. 101, and P.L.S.N.S.W., xxvi., 1901, p. 397, pl. 27, f. 93; Hedley, Mem. Austr. Mus., iv., 1903, p. 338.

LIOTELLA, Iredale, Trans. N.Z. Inst., xlvii., 1914 (1915), p. 422; Pondorbis, Bartsch, 1915.

456—**annulata** Ten. Woods, Liotia, Proc. Roy. Soc. Tasm., 1877 (1878), p. 121; Tryon, Man. Conch., x., 1888, p. 111, pl. 36, f. 20; Hedley, Mem. Austr. Mus., iv., 1903, p. 336.

457—**capitata** Hedley, Liotia, Rec. Austr. Mus., vi., 1907, p. 357, pl. 67, f. 13–14.

458—**compacta** Petterd, Liotia, Journ. of Conch., iv., 1884, p. 135; Tate, Trans. Roy. Soc. S.A., xxiii., 1899, p. 225, pl. 6, f. 7; Hedley, Rec. Austr. Mus., vi., 1905, p. 42.

459—**disjuncta** Hedley, Liotia, Mem. Austr. Mus., iv., 1903, p. 336, f. 66.

460—**johnstoni** Beddome, Cyclostrema, Proc. Roy. Soc. Tasm., 1882 (1883), p. 168; Tate, Trans. Roy. Soc. S.A., xxiii., 1899, p. 215, pl. 7, f. 7.

461—**pulcherrima** Brazier, Homalogyra, P.L.S.N.S.W., xix., 1894, p. 175, pl. 14, f. 13.

LODDERIA, Tate, Trans. Roy. Soc. S.A., xxiii., 1899, p. 215.

462—**lodderæ** Petterd, Liotia, Journ. of Conch., iv., 1884, p. 135; Hedley, P.L.S.N.S.W., xxiii., 1899, p. 802, text fig.

463—**minima** Ten. Woods, Liotia, Trans. Roy. Soc. Vict., xiv., 1877 (1878), p. 58; Hedley, P.L.S.N.S.W., xxv., 1900, p. 94, pl. 3, f. 1–3.

LIOTIA, Gray, Proc. Zool. Soc., 1847, p. 145.

464—**micans** Adams, Cyclostrema, Proc. Zool. Soc., 1850, p. 44; L. speciosa Angas, Proc. Zool. Soc., 1871, p. 19, pl. 1, f. 26.

465—**alazon** Hedley, Rec. Austr. Mus., vi., 1905, p. 49, f. 14.

Angas erroneously cited (Proc. Zool. Soc., 1871, p. 96) Liotia clathrata, Reeve, from Sydney.

LIOTINA, Fischer, Man. Conch., 1885, p. 831.

466—**botanica** Hedley, Liotia, P.L.S.N.S.W., xxxix., 1915, p. 710, pl. 81, f. 46–48.

467—**tasmanica** Ten. Woods, Liotia, Proc. Roy. Soc. Tasm., 1875 (1876), p. 153; Hedley, P.L.S.N.S.W., xix., 1895, p. 465, text fig.; and var. **scalaris**, Hedley, Mem. Austr. Mus., iv., 1903, p. 336.

CHARISMA, Hedley, P.L.S.N.S.W., xxix., 1915, p. 711.

468—**compacta** Hedley, op. cit., p. 712, pl. 81, f. 49.

469—**latebrosa** Hedley, Liotia, P.L.S.N.S.W., xxxii., 1907, p. 493, pl. 16, f. 11.

Family ORBITESTELLIDÆ.

ORBITESTELLA, Iredale, Proc. Malac. Soc., xii., 1917, p. 327.

470—**bastowi** Gatliff, Cyclostema, Proc. Roy. Soc. Vict., xix., 1906, p. 3, pl. ii., fig. 8–10.

Family NERITIDÆ.

NERITA, Linné, Syst. Nat., x., 1758, p. 776.

471—**albicilla** Linné, op. cit., p. 778; Martens Conch. Cab. (2), Pt. xi., 1889, p. 25, pl. 8, f. 1, 2.

472—**melanotragus** Smith, Zool. Alert, 1884, p. 69; Hedley, P.L.S.N.S.W., xxv., 1900, p. 500, and xli., 1917, p. 706, pl. 48, f. 13, 14.

473—**plicata** Linné, Syst. Nat., x., 1758, p. 779; Martens, Conch. Cab. (2), Pt. xi., 1889, p. 63, pl. 10, f. 6–10.

474—**polita** Linné, Syst. Nat., x., 1758, p. 778; N. rumphii, Angas, Proc. Zool. Soc., 1877, p. 188; Martens, op. cit., p. 72, pl. 3, f. 10–26.

THEODOXIS, Montfort, Conch. Syst., ii., 1810, p. 350.

475—**souverbianus** Gassies, Neritina, Act. Soc. Linn. Bordeaux, xxiv., 1861, p. 309, pl. 8, f. 7; N. pulcherrima, Angas, Proc. Zool. Soc., 1871, p. 19, pl. 1, f. 25.

Family LEPETIDÆ.

COCCULINA, Dall, Proc. U.S. Nat. Museum, 1881, p. 402.

476—**tasmanica** Pilsbry, Acmæa, Nautilus, viii., 1895, p. 128; C. meridionalis Hedley, Mem. Austr. Mus., iv., 1903, p. 331, fig. 64.

COCCULINELLA, Thiele, Conch. Cab. (2), xi., 1909, p. 21.

477—**coercita** Hedley, Cocculina, Rec. Austr. Mus., vi., 1907, p. 289, pl. 54, f. 1, 2.

LEPETA, Gray, Proc. Zool. Soc., 1847, p. 168.

478—**alta** Smith, Proc. Malac. Soc., i., 1894, p. 59, pl. 7, f. 6, 7.

Family PHENACOLEPIDÆ.

PHENACOLEPAS, Pilsbry, Nautilus, v., 1891, p. 88.

479—**cinnamomea** Gould, Patella, Proc. Boston. Soc. Nat. Hist., v., 1846, p. 151; Hedley, P.L.S.N.S.W., xli., 1917, p. 707, pl. 48, f. 17-19.

Family ACMÆIDÆ.

PATELLOIDA, Quoy & Gaimard, Zool. Astrolabe, iii., 1834, p. 349.

480—**alticostata** Angas, Patella, Proc. Zool. Soc., 1865, p. 56, pl. 2, f. 11; Hedley, P.L.S.N.S.W., xxix., 1904, p. 189; Iredale, Proc. Zool. Soc., 1914, p. 670.

481—**mixta** Reeve, Patella, Conch. Icon., viii., 1855, pl. 39, f. 129; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 713.

482—**mufria** Hedley, Acmæa, P.L.S.N.S.W., xxxix., 1915, p. 713, pl. 81, f. 50–52.

483—**petterdi** Ten. Woods, Acmæa, Proc. Roy. Soc. Tasmania, 1876 (1877), p. 155; Tectura septiformis, Angas, Proc. Zool. Soc., 1867, p. 220.

484—**subundulata** Angas, Acmæa, Proc. Zool. Soc., 1865, p. 155, and 1867, p. 220.

Angas reported (Proc. Zool. Soc., 1877, p. 189) in error, Tectura conoidea from Port Jackson.

Family PATELLIDÆ.

PATELLA, Linné, Syst. Nat., x., 1758, p. 780.

485—**perplexa** Pilsbry, Acmæa, Man. Conch., xiii., 1891, p. 50, pl. 36, f. 69–71; A. octoradiata, Hedley, P.L.S.N.S.W., xxix., 1904, p. 188. Not Patella octoradiata, Gmelin, 1791.

486—**squamifera** Reeve, Conch. Icon., viii., 1855, pl. 32, f. 94; P. aculeata Reeve, op. cit., f. 90, not Patella aculeata, Gmelin, 1791; Hedley, Austral-Antarctic Exped. Mollusca, 1916, p. 43, fig. 2.

Angas erroneously identified (Proc. Zool. Soc., 1867, p. 221), Patella pentagona Born as from Port Jackson.

CELLANA, Adams, Proc. Zool. Soc., 1869, p. 273.

487—**illibrata** Verco, Helcioniscus, Trans. Roy. Soc. S.A., xxx., 1906, p. 205, pl. 10, f. 6–14.

488—**variegata** Blainville, Patella, Dict. Sci. Nat., xxxviii., 1825, p. 10; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 714; P. tramoserica, Chemnitz. Conch. Cab., xi., 1795, pl. 197, f. 1912, 1913.

Order MONOTOCARDIA (489–1201).

Suborder TÆNIOGLOSSA (489–753).

Family LITTORINIDÆ.

MELARHAPHE, Menke, Synopsis Meth. Moll., 1828, p. 45.

489—**acutispira** Smith, Littorina, Proc. Zool. Soc., 1891, p. 487, pl. 40, f. 3.

490—**infans** Smith, Littorina, op. cit., p. 488, pl. 40, f. 4.

491—**luteola** Quoy & Gaim., Littorina, Zool. Astrolabe, ii., 1833, p. 477, pl. 33, f. 4–7; L. filosa var. subcingulata, Nevill Handlist Moll. India Museum, 1884, p. 149; Hedley, Journ. Roy. Soc. N.S.W., xlix., 1915, p. 35, f. 3.

492—**undulata** Gray, Littorina, Zool. Coll. Beechey's Voy., 1839, p. 140; Reeve, Conch. Icon., x., 1857, pl. 13, f. 67; Angas, Proc. Zool. Soc., 1877, p. 187.

493—**unifasciata** Gray, Littorina, Append. King's Intertrop. Australia, ii., 1826, p. 483; L. mauritiana, Reeve, Conch. Icon., x., 1857, pl. 17, f. 100.

TECTARIUS, Valenciennes in Humboldt Voy. Zool., ii., 1833, p. 271.

494—**pyramidalis** Quoy & Gaim., Littorina, Zool. Astrolabe, ii., 1833, p. 482, pl. 33, f. 12–15; Hedley, Journ. Roy. Soc. N.S.W., xlix., 1915, p. 35, f. 4.

BEMBICIUM, Philippi, Zeit. Malak., 1846, p. 129.

495—**melanostoma** Gmelin, Trochus, Syst. Nat., xiii., 1791, p. 3581; Crosse, Journ. de Conch., xii., 1864, p. 229, pl. 11, f. 1.

Family FOSSARIDÆ.

FOSSARUS, Philippi, Archiv. Naturgsch., i., 1841, p. 42.

496—**sydneyensis** Hedley, P.L.S.N.S.W., xxv., 1900, p. 89, pl. 3, f. 12.

Family PLANAXIDÆ.

HINEA, Gray, Proc. Zool. Soc., 1847, p. 138.

497—**brasiliana** Lamarck, Buccinum, An. s. vert., vii., 1822, p. 272; Kiener, Coq. Viv., 1834, p. 70, pl. 18, f. 59; Hedley, P.L.S.N.S.W., xxix., 1904, p. 186, = P. mollis, Sowerby, 1823.

Family RISSOIDÆ.

HAURAKIA, Iredale, Trans. N.Z. Inst., xlvii., 1914 (1915), p. 449.

498—**descrepans** Tate & May, Rissoa, Trans. Roy. Soc. S.A., xxiv., 1900, p. 99. R. incompleta, Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 468, pl. x., f. 36.

499—**profundior** Hedley, Rissoa, Rec. Austr. Mus., vi., 1907, p. 358, pl. 67, f. 15.

500—**filocincta** Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 217, pl. 37, f. 2.

MERELINA, Iredale, Trans. N.Z. Inst., xlvii., 1914 (1915), p. 449.

501—**australiæ** Frauenfeld, Cingula, Novara Exped. Moll., 1867, p. 14, pl. ii., f. 23; R. ochroleuca Brazier, P.L.S.N.S.W., xix., 1894, p. 174, pl. 14, f. 12 (not 11); Kesteven, P.L.S.N.S.W., xxxi., 1906, p. 427.

502—**cheilostoma** Ten. Woods, Rissoa, Proc. Roy. Soc. Tasm., 1876 (Feb., 1877), p. 152; A. elegans Angas, Proc. Zool. Soc., Aug., 1877, p. 174, pl. 26, f. 15.

503—**gracilis** Angas, Alvania, Proc. Zool. Soc., 1877, p. 174, pl. 26, f. 16; R. devecta, Tate, Trans. Roy. Soc. S.A., xxiii., 1899, p. 235.

504—**novarensis** Frauenfeld, Alvania, Novara Moll., 1867, p. 11, pl. 2, f. 16; Hedley, P.L.S.N.S.W., xxxii., 1907, p. 494.

505—**strangei** Brazier, Rissoa, P.L.S.N.S.W., xix., 1894, p. 173, pl. 14, f. 11 (not 12).

LIRONOBA, Iredale, Trans. N.Z. Inst., xlvii., 1914 (1915), p. 450.

506—**agnewi** Ten. Woods, Rissoa, Proc. Roy. Soc. Tasm., 1876 (1877), p. 152; May, op. cit., 1902, p. 112; f. 10; Hedley, P.L.S.N.S.W., xxix., 1904, p. 184.

507—**imbrex** Hedley, Rissoa, P.L.S.N.S.W., xxxiii., 1908, p. 469, pl. 10, f. 33.

508—**prætornatilis** Hedley, Alvania, Rec. Austr. Mus., viii., 1912, p. 139, pl. 41, f. 16.

ATTENUATA, Hedley, 1918, gen. nov., type Rissoa integella, Hedley.

509—**integella** Hedley, P.L.S.N.S.W., xxix., 1904, p. 185, pl. 9, f. 20.

510—**minutula** Tate & May, Scalaria, Trans. Roy. Soc. S.A., xxiv., 1900, p. 95; Hedley, Rec. Austr. Mus., vi., 1905, p. 52, f. 19; Rissoina elongata nom. nud., Henn, P.L.S.N.S.W., xxi., 1897, p. 500.

ESTEA, Iredale, Trans. N.Z. Inst., xlvii., 1914 (1915), p. 451.

511—**bicolor** Petterd, Rissoa, Journ. of Conch., iv., 1884, p. 137; Gatliff & Gabriel, Proc. Roy. Soc. Vict., xxvi., 1913, p. 69, pl. 8, f. 5, 6.

512—**flammea** Frauenfeld, Sabanæa, Novara Exped. Moll., 1867, p. 12, pl. 2, f. 22; Hedley, Endeavour Zool. results, ii., 1911, p. 105.

513—**frauenfeldi** Frauenfeld, Rissoa, Novara Exped. Moll., 1867, p. 10, pl. 2, f. 13.

514—**incidata** Frauenfeld, Sabanæa, Novara Exped. Moll., 1867, p. 12, pl. 2, f. 19.

515—**olivacea** Frauenfeld, Alvania, Novara Exped. Moll., 1867, p. 11, pl. 2, f. 14.

516—**praeda** Hedley, Rissoa, P.L.S.N.S.W., xxxiii., 1908, p. 468, pl. 10, f. 35.

517—**pulvilla** Hedley, Rissoa, P.L.S.N.S.W., xxx., 1906, p. 526, pl. 32, f. 25.

518—**pyramidata** Hedley, Scrobs, Mem. Austr. Mus., iv., 1903, p. 354, f. 77.

519—**salebrosa** Frauenfeld, Rissoa, Novara Exped. Moll. 1867, p. 11, pl. 2, f. 15.

ANABATHRON, Frauenfeld, Novara Exped. Moll., 1867, p. 13.

520—**contabulatum** Frauenfeld, op. cit., p. 13, pl. 2, f. 20a.

520a—**contabulatum lene,** nom. nov. for Frauenfeld, op. cit., fig. 20b.

521—**emblematicum** Hedley, Rissoa, P.L.S.N.S.W., xxx., 1906, p. 526, pl. 32, f. 24.

EPIGRUS, Hedley, Mem. Austr. Mus., iv., 1903, p. 355.

522—**badius** Petterd, Rissoa, Journ. of Conch., iv., 1884, p. 138; R. verconis, Tate, T.R.S.S.A., xxiii., 1899, p. 233; Id. Gatliff & Gabriel, Proc. Roy. Soc. Vict., xxvi., 1913, p. 68, pl. viii., fig. 3.

523—**cylindraceus** Ten. Woods, Rissoina, P.L.S.N.S.W., ii., 1877 (1878), p. 266; Hedley, Mem. Austr. Mus., iv., 1903, p. 356, fig. ; R. ischna, Tate, T.R.S.S.A., xxiii., p. 233; R. simsoni, Tate & May, T.R.S.S.A., xxiv., 1900, p. 100.

524—**dissimilis,** Watson, Eulima, Chall. Zool., xv., 1886, p. 522, pl. 37, f. 5.

525—**protractus** Hedley, P.L.S.N.S.W., xxix., 1904, p. 185, pl. 8, f. 8-11.

AMPHITHALAMUS, Carpenter, Ann. Mag. Nat. Hist. (3), xv., 1865, p. 181.

526—**jacksoni,** Brazier, P.L.S.N.S.W., xix., 1895, p. 695; R. badia, Watson, Chall. Zool., xv., 1886, p. 612, pl. 46, f. 3.

527—**petterdi** Brazier, P.L.S.N.S.W., xix., 1895, p. 697; Tate & May, op. cit., xxvi., 1901, pl. 26, f. 73.

528—**scrobiculator** Watson, Rissoa, Chall. Zool., xv., 1886, p. 611, pl. 46, f. 4.

NOTOSETIA, Iredale, Trans. N.Z. Inst., xlvii., 1914 (1915), p. 452.

529—**atropurpurea** Frauenfeld, Setia, Novara Exped. Moll., 1867, p. 13, pl. 13, f. 21.

530—**nitens** Frauenfeld, Setia, Novara Exped. Moll., 1867, p. 13, pl. 2, f. 22.

531—**procincta** Hedley, Rissoa, P.L.S.N.S.W., xxxiii., 1908, p. 469, pl. 10, f. 34.

LÆVILITORINA, Pfeffer, Jahr. Anst. Hamburg, iii., 1886, p. 81.

532—**mariæ** Ten. Woods, Rissoa, Proc. Roy. Soc. Tasm., 1875 (1877), p. 147; Tryon, Man. Conch., ix., 1887, p. 354, pl. 71, f. 9; Hedley, P.L.S.N.S.W., xxx., 1906, p. 527.

E. A. Smith erroneously records (Proc. Malac., i., 1894, p. 60) Rissoa deliciosa, Jeffreys, from 410 fath. off Sydney.

RISSOINA, D'Orbigny, Voy. Amer. Merid., 1840, p. 52.

533—**cretacea** Ten. Woods, P.L.S.N.S.W., ii., 1878, p. 265; Hedley, Mem. Austr. Mus., iv., 1903, p. 353, f. 76.

534—**elegantula** Angas, Proc. Zool. Soc., 1880, p. 417, pl. 40, f. 10; Henn, P.L.S.N.S.W., xxi., 1897, p. 500.

535—**fasciata** Adams, Proc. Zool. Soc., 1851 (1853), p. 264; R. smithi, Angas, Proc. Zool. Soc., 1867, p. 114, pl. 13, f. 21; and R. cincta, Angas, op. cit., p. 114, pl. 13, f. 22; R. hanleyi, Schwartz, Monog. Rissoina, 1860, p. 64, pl. 4, f. 28; R. flexuosa, Gould, Proc. Soc. Nat. Hist., vii., 1861, p. 400.

536—**variegata** Angas, Proc. Zool. Soc., 1867, p. 113, pl. 13, f. 19.

RISSOLINA, Gould, Proc. Boston Soc. Nat. Hist., vii., 1861, p. 401.

537—**angasi** Pease, Rissoina, Am. Journ. Conch., vii., 1872, p. 20; R. turricula Angas (not Pease, 1860), Proc. Zool. Soc., 1867, p. 114, pl. 13, f. 20.

538—**crassa** Angas, Rissoina, Proc. Zool. Soc., 1871, p. 17, pl. 1, f. 16.

RISSOPSIS, Garrett, Proc. Acad. Nat. Sci., Philad., 1873, p. 228.

539—**maccoyi** Ten. Woods, Proc. Roy. Soc. Tasm., 1876 (1877), p. 154; Hedley, P.L.S.N.S.W., xxv., 1900, p. 505, pl. 26, f. 11.

STIVA, Hedley, P.L.S.N.S.W., xxix., 1904, p. 192.

540—**ferruginea** Hedley, op. cit., p. 192, pl. 9, f. 23–5.

DIALA, Adams, Ann. Mag. Nat. Hist. (3), viii., 1861, p. 242.

541—**lauta** Adams, Ann. Mag. Nat. Hist. (3), x., 1862, p. 298; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 286, pl. 18, f. 58.

542—**monile** Adams, Alaba, Ann. Mag. Nat. Hist. (3), x., 1862, p. 296; Hedley, P.L.S.N.S.W., xxx., 1906, p. 523, pl. 33, f. 36.

543—**phasianella** Angas, Alaba, Proc. Zool. Soc., 1867, p. 113, pl. 13, f. 18.

544—**translucida** Hedley, P.L.S.N.S.W., xxx., 1906, p. 522, pl. 33, f. 35.

OBTORTIO, Hedley, Mem. Austr. Mus., iii., 1899, p. 412.

545—**lutosus** Hedley, P.L.S.N.S.W., xxxix., 1916, p. 716, pl. 81, f. 53.

CITHNA, Adams, Proc. Zool. Soc., 1863, p. 113.

546—**angulata** Hedley, Rec. Austr. Mus., vi., 1907, p. 291, pl. 55, f. 16.

Family ASSEMANIIDÆ.

ASSEMANIA, Fleming, Hist. Brit. Anim., 1828, p. 275.

547—**pagodella** Hedley, P.L.S.N.S.W., xxvii., 1903, p. 603, pl. 29, f. 6.

548—**tasmanica** Ten. Woods, Proc. Roy. Soc. Tasm., 1875 (1876), p. 79; Hedley, P.L.S.N.S.W., xxx., 1906, p. 527, pl. 32, f. 27–29.

Family HYDROBIIDÆ.

TATEA, Ten. Woods, Proc. Roy. Soc. Tasm., 1878 (1879), p. 72.

549—**paradisiaca** Pilsbry, Proc. Acad. Nat. Sci., Philad., 1897, p. 360, pl. 9, f. 9, 10.

550—**rufilabris** Adams, Diala, Ann. Mag. Nat. Hist. (3), x., 1862, p. 298; Smith, J. Linn. Soc. Zool., xvi., 1881, p. 268, pl. 7, f. 19.

POTAMOPYRGUS, Stimpson, Am. Journ. Conch., i., 1865, p. 53.

551—**ruppiæ** Hedley, Rec. Austr. Mus., viii., 1912, p. 140, pl. 41, f. 17.

Family LITIOPIDÆ.

LITIOPA, Rang, Ann. Sci. Nat., xvi., 1829, p. 303.

552—**limnophysa** Melvill & Standen, Journ. of Conch., viii., 1896, p. 305, pl. 9, f. 72; L. melanostoma, Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 462, pl. 10, f. 30, 31.

Family TRUNCATELLIDÆ.

ACMEA, Hartmann Neue Alpina, i., 1821, p. 204.

553—**valida** Pfeiffer, Truncatella, Zeit. Malak., 1846, p. 182; Smith, Monog. Christmas Isl., 1900, p. 59, pl. 8, f. 21, 22; T. brazieri Cox, Monog. Austr. Land Shells, 1868, p. 93, pl. 15, f. 12.

Family HIPPONICIDÆ.

HIPPONIX, Defrance, Bull. Soc. Philom., 1819, p. 8.

554—**foliacea** Quoy & Gaimard, Zool. Astrolabe, iii., 1835, p. 439, pl. 72, f. 41–45.

CHEILEA, Modeer, K. Vetensk. Akad nya Handl., xiv., 1793, p. 110.

555—**equestris porosa,** Reeve, Calyptræa, Conch. Icon., xi., 1858, pl. 5, f. 20.

Amalthea coxi Sowerby, Proc. Malac. Soc., viii., 1908, p. 17, pl. 1, f. 9–11, from Port Stephens, is a Cirripede, probably Acasta glans.

Family CALYPTRÆIDÆ.

SIGAPATELLA, Lesson, Zool. Coquille, ii., 1830, p. 389.

556—**calyptræformis** Lamarck, Trochus, An. s. vert., vii., 1822, p. 12; Crepidula tomentosa Quoy & Gaim., Zool. Astrolabe, iii., 1835, p. 419, pl. 72, f. 1–5; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 288.

557—**hedleyi** Smith, Terra Nova Exped. Zool., ii., 1915, p. 84, pl. 1, f. 23–5.

CREPIDULA, Lamarck, Mem. Soc. N.H. Paris, 1799, p. 78.

558—**aculeata** Gmelin, Patella, Syst. Nat., xiii., 1791, p. 3693; Watson, Chall. Zool., xv., 1886, p. 458.

559—**immersa** Angas, Proc. Zool. Soc., 1865, p. 57, pl. 2, f. 12.

Angas erroneously recorded (Proc. Zool., 1867, p. 211) Galerus pellucidus from Sydney.

Family CAPULIDÆ.

CAPULUS, Montfort, Conch. Syst., ii., 1810, p. 55.

560—**devotus** Hedley, P.L.S.N.S.W., xxix., 1904, p. 190, pl. 8, f. 15–16.

561—**violaceus** Angas, Proc. Zool. Soc., 1867, p. 114, pl. 13, f. 23.

Family CERITHIIDÆ.

CERITHIUM, Brugiere, Encycl. Meth. vers (1), 1789, p. xv.

562—**morus** Lamarck, var. **carbonarium** Sowerby (not Philippi), Conch. Icon., xv., 1865, pl. 9, f. 9; Angas, Proc. Zool. Soc., 1877, p. 186; Smith, Zool. Coll. Alert, 1884, p. 65.

ATAXOCERITHIUM, Tate, Journ. Roy. Soc. N.S.W., xxxii., 1894, p. 179.

563—**serotinum** Adams, Cerithium, Thes. Conch., ii., 1855, p. 861, pl. 180, f. 102; C. rhodostoma Angas, Proc. Zool. Soc., 1871, p. 95.

BITTIUM, Gray, Proc. Zool. Soc., 1847, p. 154.

564—**cylindricum** Watson, Chall. Zool., xv., 1886, p. 550, pl. 39, f. 5.

565—**fuscocapitulum** Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 217, pl. 38, f. 10, 11.

566—**granarium** Kiener, Cerithium, Coq. Viv., 1842, p. 72, pl. 19, f. 5; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 718, pl. 77, f. 6.

567—**icarus** Bayle, Cerithium, Journ. de Conch., xxviii., 1880, p. 249; B. furvum Watson, Chall. Zool., xv., 1886, p. 556, pl. 38, f. 5; B. variegatum Brazier, P.L.S.N.S.W., xix., 1894, p. 172, pl. 14, f. 9.

PYRAZUS, Montfort, Conch. Syst., ii., 1810, p. 458.

568—**anguliferus** Sowerby, Lampania, Conch. Icon., xv., 1866, pl. 1, f. 4; Brazier, P.L.S.N.S.W., iv., 1880, p. 388.

569—**australis** Quoy & Gaim., Zool. Astrolabe, iii., 1834, p. 131, pl. 55, f. 7.

570—**herculeus** Martyn, Clava, Univ. Conch., i., 1784, pl. 13; Hedley, P.L.S.N.S.W., xxx., 1906, p. 529, and Journ. Roy. Soc. N.S.W., xlix., 1915, p. 47, f. 12.

CERITHIOPSIS, Forbes & Hanley, Brit. Moll., ii., 1853, p. 367.

571—**angasi** Semper, Cat. Mus. Godeffroy, v., 1874, p. 108; C. clathrata Angas (not Adams), Proc. Zool. Soc., 1871, p. 16, pl. 1, f. 12.

572—**cacuminatus** Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 218, pl. 37, f. 4.

573—**cessicus** Hedley, P.L.S.N.S.W., xxx., 1906, p. 529, for C. minimum Ten. Woods (preocc.), and xxv., 1901, p. 722, f. 20.

SEILA, Adams, Ann. Mag. Nat. Hist. (3), vii., 1861, p. 131.

574—**albosutura** Ten. Woods, Cerithiopsis, Proc. Roy. Soc. Tasm., 1876 (Feb., 1877), p. 140; C. purpurea Angas, Proc. Zool. Soc., June, 1877, p. 36, pl. 5, f. 7; Smith, Ann. Natal Museum, i., 1906, p. 44.

575—**crocea** Angas, Cerithiopsis, Proc. Zool. Soc., 1871, p. 16, pl. 1, f. 13; Ten. Woods, Proc. Roy. Soc. Tasm., 1877, p. 36.

576—**halligani** Hedley, Cerithiopsis, Rec. Austr. Mus., vi., 1905, p. 51, f. 16.

577—**turritelliformis** Angas, Bittium, Proc. Zool. Soc., 1877, p. 174, pl. 26, f. 14; S. attenuata Hedley, P.L.S.N.S.W., xxv., 1900, p. 91, pl. 3, f. 9.

Family TRIPHORIDÆ.

TRIPHORA, Blainville, Dict. Sci. Nat., lv., 1828, p. 344.

578—**albovittata** Hedley, P.L.S.N.S.W., xxvii., 1903, p. 609, pl. 32, f. 26–27.

579—**ampulla** Hedley, op. cit., p. 615, pl. 33, f. 38–39.

580—**angasi** Crosse & Fischer, Journ. de Conch., xiii., 1865, p. 46, pl. 1, f. 12, 13; Hedley, op. cit., p. 610.

581—**cinerea** Hedley, op. cit., p. 612, pl. 33, f. 36–37.

582—**fasciata** Ten. Woods, Proc. Roy. Soc. Tasm., 1878 (1879), p. 34; Hedley, op. cit., p. 615, pl. 33, f. 40–41.

583—**granifera** Brazier, P.L.S.N.S.W., xix., 1894, p. 173, pl. 14, f. 10, and xxvii., 1903, p. 610, pl. 33, f. 28–29.

584—**innotabilis** Hedley, op. cit., p. 608, pl. 32, f. 23–25.

585—**kesteveni** Hedley op. cit., p. 618, pl. 33, f. 45.

586—**labiata** Adams, Proc. Zool. Soc., 1851 (1854), p. 279; Hedley, op. cit., p. 617, pl. 33, f. 42–44.

587—**maculosa** Hedley, op. cit., p. 614, pl. 32, f. 32–33.

588—**nigrofusca** Adams, Proc. Zool. Soc., 1851 (1854), p. 278; Hedley, op. cit., p. 611, pl. 33, f. 34–35.

589—**nocturna** Hedley, op. cit., p. 613, pl. 32, f. 30–31.

590—**tasmanica** Ten. Woods, Proc. Roy. Soc. Tasm., 1875 (1876), p. 28; Hedley, op. cit., p. 612, pl. 32, f. 22.

Family TURRITELLIDÆ.

TURRITELLA, Lamarck, Mem. Soc. N.H. Paris, 1799, p. 74.

591—**crenulata** Donald, Proc. Malac. Soc., iv., 1900, p. 52, pl. 5, f. 2.

592—**curialis** Hedley, Rec. Austr. Mus., vi., 1907, p. 357, pl. 67, f. 19.

593—**gunnii** Reeve, Conch. Icon., v., 1849, pl. 9, f. 45; Angas, Proc. Zool. Soc., 1877, p. 185; T. philippensis, Watson, Chall. Zool., xv., 1886, p. 479, pl. 30, f. 6.

594—**opulenta** Hedley, Rec. Austr. Mus., vi., 1907, p. 292, pl. 54, f. 9.

595—**parva** Angas, Torcula, Proc. Zool. Soc., 1877, p. 174, pl. 26, f. 17.

596—**scitula** Donald (as var. of T. quadrata), Proc. Malac. Soc., iv., 1900, p. 54, pl. 5, f. 9.

597—**sinuata** Reeve, Conch. Icon., v., 1849, pl. 11, f. 62.

598—**smithiana** Donald, Proc. Malac. Soc., iv., 1900, p. 52, pl. 5, f. 1.

599—**sophiæ** Brazier, P.L.S.N.S.W., viii., 1883, p. 227; T. incisa. T. Wds., 1877.

600—**subsquamosa** Dunker, Mal. Blatt., xviii., 1871, p. 152; T. lamellosa Watson, Chall. Zool., xv., 1886, p. 474, pl. 29, f. 6.

Smith observes (Ann. Mag. Nat. Hist. (8), xv., 1915, p. 370) that T. incisa, Reeve, Conch. Icon., v., 1849, pl. 11, f. 55, is erroneously cited from Sydney.

Family CÆCIDÆ.

CÆCUM, Fleming, Edinb. Encycl., vii., 1824, p. 67.

601—**amputatum** Hedley, P.L.S.N.S.W., xviii., 1894, p. 504, text fig.

602—**lilianum** Hedley, P.L.S.N.S.W., xxvii., 1903, p. 603, pl. 29, f. 7.

STREBLOCERAS, Carpenter, Proc. Zool. Soc., 1858, p. 440.

603—**cygnicollis** Hedley, P.L.S.N.S.W., xxix., 1904, p. 189, pl. 8, f. 12–14.

Family TRICHOTROPIDÆ.

CROSSEA, Adams, Ann. Mag. Nat. Hist. (3), xv., 1865, p. 323.

604—**carinata** Hedley, Mem. Austr. Mus., iv., 1903, p. 345, f. 71.

605—**concinna** Angas, Proc. Zool. Soc., 1867, p. 911, pl. 44, f. 14.

606—**labiata** Ten. Woods, Proc. Roy. Soc. Tasm., 1875 (1876), p. 151; Hedley, P.L.S.N.S.W., xxv., 1900, p. 500, pl. 26, f. 18.

607—**naticoides** Hedley, Rec. Austr. Mus., vi., 1907, p. 290, pl. 54, f. 6–7.

LIPPISTES, Montfort, Conch. Syst., ii., 1810, p. 126.

608—**torcularis** Ten. Woods, Cingulina, P.L.S.N.S.W., ii., 1878, p. 263; Hedley, Rec. Austr. Mus., iv., 1901, p. 22, f. 2.

609—**zodiacus** Hedley, P.L.S.N.S.W., xxxii., 1907, p. 502, pl. 18, f. 30.

SIRIUS, Hedley, P.L.S.N.S.W., xxv., 1900, p. 88.

610—**badius** Ten. Woods, P.L.S.N.S.W., ii., 1878, p. 264; Hedley, op. cit., xxv., 1900, p. 88, pl. 3, f. 8.

COUTHOUYIA, Adams, Ann. Mag. Nat. Hist. (3), v., 1860, p. 410.

611—**gracilis** Brazier, Vanikoro, P.L.S.N.S.W., xix., 1894, p. 169, pl. 14, f. 4; Hedley, op. cit., xxv., 1900, p. 506, pl. 26, f. 13.

Family VERMETIDÆ.

VERMICULARIA, Lamarck, Mem. Soc. N.H. Paris, 1799, p. 78.

612—**nodosa** Hedley, Rec. Austr. Mus., vi., 1907, p. 292, pl. 54, f. 8.

613—**sipho** Lamarck, Serpula, An. s. vert., v., 1818, p. 262; V. arenarius Quoy & Gaimard, Astrolabe Zool, iii., 1834, p. 289, pl. 67, f. 8–10; Hedley, P.L.S.N.S.W., xxvii., 1903, p. 602.

614—**waitei** Hedley, Vermetus, Mem. Austr. Mus., iv., 1903, p. 346, f. 72.

Angas has cited, probably erroneously (Proc. Zool. Soc., 1867, p. 211), a tropical species, Bivona quoyi, H. & A. Adams, from Port Jackson.

STEPHOPOMA, Morch, Journ. de Conch., viii., 1860, p. 42.

615—**tricuspe** Morch, Proc. Zool. Soc., 1866, p. 150, pl. 35, f. 1; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 294, pl. 19, f. 72–74.

SILIQUARIA, Bruguiere, Encycl. Meth. vers i., 1789, p. xv.

616—**weldii** Ten. Woods, Tenagodes, Proc. Roy. Soc. Tasm., 1875 (1876), p. 144; Tryon, Man. Conch., viii., 1886, p. 181, pl. 58, f. 28; Hedley, Rec. Austr. Mus., vi., 1905, p. 42.

MAGILINA, Velain, Arch. Zool. Exper., vi., 1877, p. 106.

617—**caperata** Tate & May, Thylacodes, Trans. Roy. Soc. S. A., xxiv., 1900, p. 94, and P.L.S.N.S.W., xxvi., 1901, p. 377, pl. 23, f. 14; op. cit., xxvii., 1902, p. 19, figg.; op. cit., xxxiii., 1908, p. 457, pl. 10, f. 37–8.

Family JANTHINIDÆ.

JANTHINA, Bolten, Mus. Bolt., 1798, p. 75.

618—**capreolata** Montrouzier, Journ. de Conch., vii., 1859, p. 375, and viii., 1860, p. 114, pl. 2, f. 4.

619—**globosa** Swainson, Zool. Illustr., ii., 1821, pl. 85; J. prolongata Blainville, Dict. Sci. Nat., 1822, p. 155, and Man. Malac., pl. 37, bis f. 1.

620—**umbilicata** D'Orbigny, Voy. Amer. Merid., 1841, p. 414; Reeve, Conch. Icon., xi., 1858, pl. 5, f. 22.

621—**violacea** Bolten, Mus. Bolt., 1798, p. 75 for Knorr (2), pl. 30, f. 2, 3; Angas, Proc. Zool. Soc., 1867, p. 230; J. penicephala, Peron Voy. Terr. Austr., Atlas, 1804, pl. xxx., fig. 4.

RECLUZIA, Petit, Journ. de Conch., iv., 1863, p. 117.

622—**lutea** Bennett, Narr. Whaling Voy., ii., 1840, p. 298; R. hargravesi Cox, Proc. Zool. Soc., 1870, p. 172, pl. 16, f. 8; Brazier, P.L.S.N.S.W., xviii., 1894, p. 536.

Family STRUTHIOLARIIDÆ.

STRUTHIOLARIA, Lamarck, Encycl. Meth. vers, 1816, Expl. Plate 431, f. 1.

623—**scutulata** Martyn, Buccinum, Univ. Conch., 1784, pl. 55; Watson. Chall. Zool., xv., 1886, p. 414.

ZEMIRA, H. & A. Adams, Gen. Rec. Moll., 1853, p. 110.

624—**australis** Sowerby, Eburna, Conch. Illustr., 1841, f. 5; Watson, Chall. Zool., xv., 1886, p. 222.

Family MERRIIDÆ.

MERRIA, Gray, Zool. Beechey's Voy., 1839, p. 137; Narica D'Orbigny, Moll. Cuba, ii., 1842, p. 39; Vanikoro (rejected as vernacular), Quoy & Gaimard, Astrolabe Zool., ii., 1832, p. 239.

625—**orbignyana** Recluz, Proc. Zool. Soc., 1843 (1844), p. 140; and Mag. de Zool., 1845, p. 30, pl. 124, f. 2.

626—**sigaretiformis** Potiez & Michaud, Velutina, Gal. de Douai, 1838, p. 508, pl. 35, f. 21-22; Hedley, Rec. Austr. Mus., viii., 1912, p. 142, pl. 42, f. 21–22.

Angas has erroneously reported (Proc. Zool. Soc., 1867, p. 212) Vanikoro granulata, Recluz, and V. quoyana, Adams, from Sydney.

Whitelegge has erroneously reported (Journ. Roy. Soc. N.S. Wales, xxiii., 1889, p. 259) Vanikoro cuvieriana Recluz and V. gaimardi, Adams, from Sydney.

NARICAVA, Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 294.

627—**angasi** Adams, Adeorbis, Proc. Zool. Soc., 1863, p. 424, pl. 37, f. 11, 12.

628—**angulata** Hedley, Adeorbis, Rec. Austr. Mus., vi., 1905, p. 50, f. 15.

From 410 fathoms off Sydney, Smith has erroneously recorded (Proc. Malac., i., 1894, p. 60) Seguenzia carinata Jeffreys.

Family XENOPHORIDÆ.

XENOPHORA, Fischer, Mus. Demidoff, iii., 1807, p. 213.

629—**tatei** Harris, Brit. Mus. Cat. Tert. Moll. Austr., i., 1897, p. 254, pl. 7, f. 7; Hedley, Mem. Austr. Mus., iv., 1903, p. 357.

Family STROMBIDÆ.

STROMBUS, Linné, Syst. Nat., x., 1758, p. 742.

630—**campbellii** Griffiths & Pidgeon, Anim. Kingdom., xii., 1834, p. 600, pl. 25, f. 6; Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 459.

631—**elegans** Sowerby, Thes. Conch., i., 1842, p. 30, pl. 7, f. 43, 48; Angas, Proc. Zool. Soc., 1877, p. 185.

632—**luhuanus** Linné, Syst. Nat., x., 1758, p. 744; Sowerby, Thes. Conch., i., 1842, p. 29, pl. 7, f. 54; Hedley, Journ. Roy. Soc. N.S.W., xlviii., 1915, p. 28.

633—**urceus** Linné, Syst. Nat. x., 1758, p. 745; Sowerby, Thes. Conch., i., 1842, pl. 7, f. 45, as of S. mutabilis; Hedley, P.L.S.N.S.W., xxix., 1904, p. 188.

Angas erroneously recorded (Proc. Zool. Soc., 1877, p. 186) Pterocera scorpio, Linn, from the Bottle and Glass Rocks.

Family PTEROTRACHEIDÆ.

FIROLOIDA, Lesueur, Journ. Acad. Nat. Sci. Philad., i., 1817, p. 38.

634—**desmaresti** Lesueur, op. cit., p. 39, pl. 2, f. 1; Hedley, Mem. Austr. Mus., iv., 1903, p. 402.

CARINARIA, Lamarck, Syst. Anim. s. vert., 1801, p. 98.

635—**australis** Quoy & Gaim. Astrolabe Zool., ii., 1833, p. 394, pl. 29, f. 9, 13; Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 223.

PTEROSOMA, Lesson, Mem. Soc. Hist. Nat. Paris, iii., 1827, p. 414.

636—**planum** Lesson, op. cit., p. 414, pl. 10, f. A.; Hedley, Proc. Malac. Soc., i., 1895, p. 333, f. 1–4; Crosse, Journ. de Conch., xliv., 1896, p. 212.

Family ATLANTIDÆ.

OXYGYRUS, Benson, Journ. Asiat. Soc. Bengal, vi., 1837, p. 316.

637—**keraudrenii** Lesueur, Journ. de Phys, lxxxv., 1817, p. 391, pl. 2; Hedley, Rec. Austr. Mus., vi., 1907, p. 299.

ATLANTA, Lesueur, Journ. de Phys., lxxxv., 1817, p. 390. Atlas, Blainville, Dic. Sci. Nat., xxxii., 1824, p. 271.

638—**inflata** Eydoux & Souleyet, Bonite Zool., ii., 1852, p. 378, pl. 19, f. 21–28; Hedley, Mem. Austr. Mus., iv., 1903, p. 402.

639—**rosea** Eydoux & Souleyet, op. cit., p. 377, pl. 19, f. 16–20.

640—**turriculata** D'Orbigny, Voy. Amer. Merid., v., 1836, p. 173, pl. 20, f. 5, 11.

Family EPITONIIDÆ.

EPITONIUM, Bolten, Mus. Bolt., 1798, p. 91.

641—**aculeatum** Sowerby, Scalaria, Thes. Conch., i., 1844, p. 86, bis. pl. 32, f. 35–37; Watson, Chall. Zool., xv., 1886, p. 139.

642—**australe** Lamarck, Scalaria, An. s. vert., vi., 1822, p. 228; Kiener, Coq. Viv., 1839, p. 16, pl. 6, f. 17; Angas, Proc. Zool. Soc., 1867, p. 200.

643—**bellicosum** Hedley, Rec. Austr. Mus., vi., 1907, p. 360, pl. 67, f. 18.

644—**distinctum** Smith, Scala, Proc. Zool. Soc., 1891, p. 441, pl. 35, f. 15.

645—**granosum** Quoy & Gaimard, Turritella, Zool. Astrolabe, iii., 1834, p. 138, pl. 55, f. 29–30; S. ballinensis, Smith, Ann. Mag. N.H. (6), vii., 1891, p. 139; Hedley, P.L.S.N.S.W., xxvi., 1901, p. 701, pl. 34, f. 21.

646—**hyalinum** Sowerby, Scalaria, Thes. Conch., i., 1844, p. 85, bis. pl. 32, f. 21–22; Angas, Proc. Zool. Soc., 1877, p. 183.

647—**jukesianum** Forbes, Scalaria, Voy. Rattlesnake, append. ii., 1852, p. 383, pl. 3, f. 7.

648—**levifoliatum** var. Murdoch & Suter, Trans. N.Z. Inst., xxxviii., 1906, p. 296, pl. 25, f. 35, 36; Hedley, Rec. Austr. Mus., vi., 1907, p. 290.

649—**morchi** Angas, Scala, Proc. Zool. Soc., 1871, p. 15, pl. 1, f. 7; Hedley, Mem. Austr. Mus., iv., 1903, p. 364.

650—**perplexum** Pease, Am. Journ. Conch., iii., 1867, p. 228; Martens & Langkavel, Donum Bismarckianum, 1871, p. 24, pl. 1, f. 19; Whitelegge, Journ. Roy. Soc. N.S.W., xxiii., 1889, p. 261.

651—**philippinarum** Sowerby, Thes. Conch., i., 1844, p. 86, bis. pl. 32, f. 1–3; Angas, Proc. Zool. Soc., 1867, p. 199.

652—**pyramidale** Sowerby, Scalaria, Thes. Conch., i., 1844, p. 85, bis. pl. 32, f. 4; Whitelegge, Jour. Roy. Soc. N.S.W., xxiii., 1889, p. 261.

653—**tenellum** Hutton, Scalaria, P.L.S.N.S.W., ix., 1885, p. 943; S. lineolata, Angas, Proc. Zool. Soc., 1867, p. 199.

654—**translucidum** Gatliff, Scala, Proc. Roy. Soc. Vict., xix., 1906, p. 2, pl. 1, f. 3, 4; Hedley, Rec. Austr. Mus., vi., 1907, p. 290.

655—**turrisphari** Hedley, Scala, Rec. Austr. Mus., vi., 1905, p. 52, f. 18.

656—**unilaterale** von Martens, Scalaria, Valdivia Exp. Moll., 1903, p. 118, pl. 4, f. 11; Bavay, Journ. de Conch., lx., 1913, p. 294, pl. 10, f. 12.

Whitelegge erroneously recorded (Journ. Roy. Soc. N.S.W., xxiii., 1889, p. 261) Scalaria bicarinata, Sowerby, from 18 fath. off Ball's Head.

Angas erroneously recorded (Proc. Zool. Soc., 1877, p. 183) Scala clathrus, Linné, from Port Stephens and Broken Bay; also (Proc. Zool. Soc., 1867, p. 199) Scala scalaris Linné from Port Jackson.

Family CYMATIIDÆ.

CHARONIA, Gistel, Naturg. Thier, 1848, p. 170.

657—**lampas euclia** Hedley, Endeavour Biolog. Results, ii., 1914, p. 65, pl. 8, f. 1.

658—**rubicunda** Perry, Septa, Conchology, 1811, pl. 14, f. 4.

659—**pumilo** Hedley, Lotorium, Mem. Austr. Mus. iv., 1903, p. 339; f. 68.

AUSTROTRITON, Cossmann, Essai Pal. Comp., v., 1903, p. 87[1].

[1] A. bassi Angas, Triton, Proc. Zool. Soc., 1869, p. 45, pl. 2, f. 19. (As this occurs at Corner Inlet, it will probably reach our southern border.)

660—**parkinsonius** Perry, Septa, Conchology, 1811, pl. 14; f. 1; Tritonium fusiforme Angas, Proc. Zool. Soc., 1867, p. 188.

CYMATIUM, Bolten, Mus. Bolt., 1798, p. 129.

661—**caudatum** Gmelin, Murex, Syst. Nat. xiii. 1791, p. 3535; Reeve, Conch. Icon., ii., 1844, pl. 3, f. 8; Angas Proc. Zool. Soc., 1877, p. 179.

662—**exaratum** Reeve, Triton, Conch. Icon. ii., 1844, pl. 13, f. 50; Angas, Proc. Zool. Soc., 1867, p. 188.

663—**gemmatum** Reeve, Triton, Conch. Icon., ii., 1844, pl. 15, f. 60a; Angas, Proc. Zool. Soc., 1877, p. 179.

664—**labiosum** Wood, Murex, Index, Test. suppl., 1828, p. 5, f. 18; Iredale, Proc. Malac. Soc., ix., 1910, p. 73; T. strangei, Adams & Angas, Proc. Zool. Soc., 1864, p. 35.

665—**parthenopeum** von Salis, Murex, Reis. Neap., 1793, p. 370, pl. 7, f. 1; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 719.

666—**sinense** Reeve, Triton, Conch Icon., ii., 1844, pl. 6, f. 18; Hedley, P.L.S.N.S.W., xxvi., 1901, p. 16.

667—**spengleri** Perry, Septa, 1811, pl. 14, f. 3. Watson, Chall. Zool., xv., 1886, p. 393.

Angas has erroneously reported (Proc. Zool. Soc., 1867, p. 189) T. doliarium Lamarck, from N. S. Wales, also (op. cit. p. 188) T. boltenianum from Long Bay, Sydney.

FUSITRITON, Cossmann, Essai Pal Comp., v., 1903, p. 87.

668—**kampylum** Watson, Nassaria, Chall. Zool., xv., 1886, p. 405, pl. 14, f. 12; Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 219.

669—**retiolus** Hedley, Argobuccinum, Biol. Results, Endeavour, ii., 1914, p. 73, pl. 11, f. 5.

EUGYRINA, Dall, Smithson, Miscell. Coll., xlvii., 1904, p. 132; Mayena Iredale, Proc. Malac. Soc., xii., 1917, p. 324.

670—**australasia** Perry, Biplex, Conchology, 1811, pl. 4, f. 2, 4; Smith, Proc. Malac. Soc., xi., 1915, p. 283; R. leucostoma, Lk.

GYRINEUM, Link. Beschr. Rostock. Samml., 1807, p. 123.

671—**pusillum** Broderip, Ranella, Proc. Zool. Soc., 1832, p. 194; Reeve, Conch. Icon., ii., 1844, pl. 8, f. 44; Whitelegge, Journ. Roy. Soc. N. S. Wales, xxiii., 1889, p. 247.

BURSA, Bolten, Mus. Bolt., 1798, p. 128.

672—**bufo** Bolten, Tritonium, Mus. Bolt., 1798, p. 128; Hedley, Journ. of Conch., xv., 1916, p. 42; B. hians, Angas, Proc. Zool. Soc., 1877, p. 179.

673—**granifera** Lamarck, Ranella, Encycl. Meth., 1816, pl. 414, f. 4; Angas, Proc. Zool. Soc., 1877, p. 180.

674—**mammata** Bolten, Mus. Bolt., 1798, p. 128; B. venustula, Angas, Proc. Zool. Soc., 1877, p. 180.

Family CASSIDIDÆ.

PHALIUM, Link, Rostock Samml., iii., 1807, p. 112.

675—**areola** Linné, Buccinum, Syst. Nat., x., 1758, p. 736; Kiener, Coq. Viv., 1835, p. 24, pl. 10, f. 19; Brazier, Proc. Zool. Soc., 1872, p. 837.

676—**coronulatum** Sowerby, Cassis, Tank. Cat., 1825, append. p. xx.; Reeve, Conch. Icon., v., 1848, pl. 12, f. 31; Brazier, Proc. Zool. Soc., 1872, p. 838.

677—**labiatum** Perry, Conchology, 1811, pl. 34, f. 1; C. achatina, Angas, Proc. Zool. Soc., 1867, p. 196.

678—**pila** Reeve, Cassis, Conch. Icon., v., 1848, pl. 9, f. 21; Watson, Chall. Zool., xv., 1886, p. 407.

679—**sophia** Brazier, Cassis, Proc. Zool. Soc., 1872, p. 617, pl. 44, f. 2.

680—**stadiale** Hedley, Biol. Results Endeavour, ii., 1914, p. 72, pl. 10, f. 4.

681—**thomsoni** Brazier, Cassis, P.L.S.N.S.W., i., 1875, p. 8; Hedley, Mem. Austr. Mus., iv., 1903, p. 341, pl. 36, f. 2, 3.

682—**torquatum** Reeve, Cassis, Conch. Icon., v., 1848, pl. 1, f. 1; Brazier, Proc. Zool. Soc., 1872, p. 838.

Angas has erroneously recorded (Proc. Zool. Soc., 1877, p. 183), Semicassis paucirugis from Twofold Bay.

CASSIS, Bolten, Mus. Bolt., 1798, p. 28.

683—**nana** Ten. Woods, P.L.S.N.S.W., iv., 1879, p. 108; Hedley, op. cit., xxiv., 1899, p. 434, f. 6.

Family TONNIDÆ.

TONNA, Brunnich, Zool. Fund., 1772, p. 248.

684—**perdix** Linné, Buccinum, Syst. Nat., x., 1758, p. 734; Reeve, Conch. Icon., v., 1849, pl. 6, f. 9; Macgillivrayia pelagica, Macgillivray Ann. Mag. Nat. Hist. (2), ii., 1848, p. 31; Fischer, Journ. de Conch. xi., 1863, p. 147, pl. 6, f. 7.

685—**variegata** Lamarck, Dolium, An. s. vert., viii., 1822, p. 261; Kiener, Coq. Viv., 1835, p. 9; pl. 2, f. 3; Angas, Proc. Zool. Soc., 1867, p. 197.

FICUS, Bolten, Mus. Bolt., 1798, p. 148.

686—**communis** Bolten, op. cit., p. 148; Hedley, P.L.S.-N.S.W., xxxiii., 1903, p. 461.

Family NATICIDÆ.

NATICA, Scopoli, Intr. Hist. Nat., 1777, p. 392.

687—**alapapilionis** Bolten, Cochlis, Mus. Bolt., 1798, p. 146; Reeve, Conch. Icon., ix., 1855, pl. 14, f. 60; Angas, Proc. Zool. Soc., 1877, p. 182.

688—**euzona** Recluz, Proc. Zool. Soc., 1843 (1844), p. 204, and Journ. de Conch., i., 1850, p. 381, pl. 14,

689—**gualteriana** Recluz, Proc. Zool. Soc., 1843, p. 208; Reeve, Conch. Icon., ix., 1855, pl. 25, f. 114; N. marochiensis, Angas, Proc. Zool. Soc., 1867, p. 197; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 298.

690—**sagittata,** Menke, Spm. Moll. Nov. Holl., 1843, p. 10; Philippi, Conch. Cab. n.s., ii., 1852, p. 108, pl. 15, f. 14; Watson, Chall. Zool., xv., 1886, p. 433.

691—**subcostata** Ten. Woods, P.L.S.N.S.W., ii., 1878, p. 263; Hedley, Rec. Austr. Mus., iv., 1901, p. 22, f. 1.

Angas erroneously identified (Proc. Zool. Soc., 1877, p. 183), N. colliei from the Parramatta River and recorded N. areolata Recluz in place of N. euzona.

POLINICES, Montfort, Conch. Syst., ii., 1810, p. 222.

692—**aulacoglossa** Pilsbry & Vanatta, Proc. Acad. Nat. Sci. Philad., lv., 1908, p. 558, pl. 29, f. 1, 2, 3; Hedley. P.L.S.N.S.W., xxxviii., 1913, p. 300.

693—**conicus** Lamarck, Natica, An. s. vert., vi., 1822, p. 198; Reeve, Conch. Icon., ix., 1855, pl. 12, f. 48.

694—**ephebus** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 720, pl. 82, f. 62, 63.

695—**filosus** Reeve, Natica, Conch. Icon., ix., 1855, pl. 17, f. 72.

696—**incei** Philippi, Natica, Proc. Zool Soc., 1851 (July, 1853), p. 233; Conch. Cab. n.s., ii., 1853, p. 142, pl. 19, f. 5; Brazier, P.L.S.N.S.W., viii., 1883, p. 225.

697—**melastoma** Swainson, Natica, Zool. Illustr., 1st ser., 1822, pl. 79.

698—**plumbeus** Lamarck, An. s. vert., vi., 1822, p. 198; N. strangei, Reeve, Conch. Icon., ix., 1855, pl. 18, f. 81.

FRIGINATICA, Hedley, Moll. Australasian Antarctic Exped., 1916, p. 51.

699—**beddomei** Johnston, Natica, Proc. Roy. Soc., Tasm., 1884 (1885), p. 222; Brazier, P.L.S.N.S.W., xix., 1895, p. 692.

SINUM, Bolten, Mus. Bolt., 1798, p. 14.

700—**coarctatum** Reeve, Sigaretus, Conch. Icon., xv., 1864, pl 4, f. 17; Angas, Proc. Zool. Soc., 1877, p. 183.

701—**nitidum** Reeve, Sigaretus, Conch. Icon.. xv., 1864, pl. 4, f. 20; Angas, Proc. Zool Soc., 1867, p. 198.

702—**planulatum** Recluz, Conch. Illustr., May, 1843, p. 21, pl. 3, f. 4; planum Philippi, Abbild., i., July, 1844, p. 146, pl. 1, f. 7.

703—**umbilicatum** Quoy & Gaimard, Natica, Astrolabe Zool., ii., 1833, p. 234, pl. 66, f. 22-23; Angas, Proc. Zool. Soc., 1867, p. 199.

PELLILITORINA, Pfeffer, Jahrb. Hamburg Wiss. Anstal., iii., 1886, p. 77; Larinopsis, Gatliff & Gabriel, 1916.

704—**morchi** Adams & Angas, Amauropsis, Proc. Zool. Soc., 1863, p. 423; Hedley, P.L.S.N.S.W., xxvi., 1902, p. 700, pl. 34, f. 19–20.

Family LAMELLARIIDÆ.

705—**Marseniopsis** sp., Lamellaria indica, Angas, Proc. Zool. Soc., 1867, p. 199.

Family CYPRAEIDÆ.

CYPRAEA, Linné, Syst. Nat., x., 1758, p. 718.

706—**angustata comptoni** Gray, Voy. Fly, ii., 1847, p. 356, pl. 1, f. 3; Henn, P.L.S.N.S.W., xx., 1896, p. 520.

706a—**angustata piperata** Gray, Zool. Journ., i., 1825, p. 498; Angas, Proc. Zool. Soc., 1867, p. 206.

707—**annulus** Linné Syst. Nat., x., 1758, p. 723; Brazier, Proc. Zool. Soc., 1872, p. 83.

708—**arabica** Linné, op. cit., p. 718; Brazier, op. cit., p. 83.

709—**armenaiaca** Verco, Trans. Roy. Soc., S.A., xxxvi., 1912, p. 213, pl. 10, f. 1-3; C. umbilicata, Sowerby Tank. Cat., 1825, p. xxx, not C. umbilicata, Dillwyn, Index. Hist. Conch. Lister, 1823, p. 32; Iredale, Proc. Malac. Soc., xii., 1916, p. 93.

710—**asellus** Linné, op. cit., p. 722; Brazier, op. cit., p. 82.

711—**caputserpentis** Linné, op. cit., p. 720; Brazier, op. cit., p. 83.

711a—**caputserpentis caputanguis** Philippi, Zeit. Malak., 1849, p. 24; Henn, P.L.S.N.S.W., xx., 1896, p. 520.

712—**carneola** Linné, op. cit., p. 719; Brazier, op. cit., p. 82.

713—**caurica** Linné, op. cit., p. 723; Brazier, op. cit., p. 85.

714—**clandestina** Linné, Syst. Nat., xii., 1767, p. 1177; Brazier, op. cit. p. 84.

715—**erosa** Linné, Syst. Nat., x., 1758, p. 723; Brazier, op. cit., p. 85.

716—**errones** Linné, op. cit., p. 723; Brazier, op. cit., p. 85.

716a—**errones cruenta** Gmelin, Syst. Nat., xiii., 1791, p. 3420; Brazier, op. cit., p. 85.

717—**felina** Gmelin, Syst. Nat., xiii., 1791, p. 3412; Brazier, op. cit., p. 82.

718—**fimbriata** Gmelin, Syst. Nat., xiii., 1791, p. 3420; Brazier, op. cit., p. 82.

718a—**fimbriata notata** Gill, Ann. Lyc., N. York, vi., 1858, p. 255, pl. 9, f. 1-3; C. macula Brazier, Proc. Zool. Soc., 1872, p. 82.

719—**flaveola** Linné, op. cit., p. 724; Brazier, op. cit., p. 84.

720—**helvola** Linné, op. cit., p. 724; Henn, P.L.S.N.S.W. xx., 1896, p. 520.

721—**hirundo** Linné, op. cit., p. 722; Henn, op. cit., p. 520.

722—**isabella** Linné, op. cit., p. 722; Brazier, op. cit., p. 82.

723—**limacina** Lamarck, Ann. Mus., xvi., 1810, p. 101; Brazier, op. cit., p. 86.

724—**lutea** Gronov, Zoophyl., 1781, pl. 19, f. 17; Henn, op. cit., p. 520.

725—**lynx** Linné, op. cit., p. 721; Brazier, op. cit., p. 83.

726—**miliaris** Gmelin, Syst. Nat., xiii., 1791, p. 3420; Brazier, op. cit., p. 85.

727—**moneta** Linné, op. cit., p. 723; Henn, op. cit., p. 520.

728—**poraria** Linné, op. cit., p. 724; Brazier, op. cit., p. 84.

729—**punctata** Linné, Syst. Nat., xii., 1767, p. 548; Brazier, Journ. of Conch., ii., 1879, p. 195.

730—**tabescens** Dillwyn, Syst. Cat., i., 1817, p. 463; Brazier, op. cit., p. 83.

731—**scurra** Gmelin, Syst. Nat., xiii., 1791, p. 3409; Brazier, op. cit., p. 83.

732—**subviridis** Reeve, Conch. Icon., iii., 1845, pl. 12, f. 48; Brazier, op. cit., p. 84.

733—**vitellus** Linné, op. cit., p. 721; Cambage, P.L.S. N.S.W., xli., 1916, p. 192.

734—**xanthodon** Sowerby, Conch. Illustr., 1832, p. 9, f. 18; Brazier, op. cit., p. 84.

Lea erroneously recorded (P.L.S.N.S.W., xix., 1895, p. 708) C. mauritiana as from Long Bay, Sydney.

TRIVIA, Broderip, Penny Cyclopædia, viii., 1837, p. 256.

735—**australis** Lamarck, Cypraea, An. s. vert., vii., 1822, p. 404; Quoy & Gaim. Astrolabe Zool., iii., 1834, p. 48, pl. f. 19–26.

736—**caelatura** nom nov. for avellanoides Hedley not McCoy, Rec. Austr. Mus., vi., 1907, p. 293, pl. 55, f. 17-18.

737—**globosa** Sowerby, Conch. Illustr., 1832, p. 12, f. 34; Shaw, Proc. Malac. Soc., viii., 1909, p. 310.

738—**insecta** Mighels, Cypraea, Proc. Boston Soc. Nat. Hist., ii., 1845, p. 24; Brazier, op. cit., p. 86.

739—**oryza** Lamarck, Cypraea, Ann. Mus., xvi., 1810, p. 104; Shaw, Proc. Malac. Soc., viii., 1909, p. 308; Smith, Ann. Mag. Nat. Hist. (6), x., 1892, p. 129.

740—**staphylaea** Linné, Syst. Nat., x., 1758, p. 725; Brazier, op. cit., p. 86.

Angas erroneously reported (Proc. Zool. Soc., 1871, p. 94) T. candidula from the Bottle and Glass Rocks; vide Brazier, P.L.S.N.S.W., vii., 1882, p. 120.

ERATO, Risso, Hist. Nat. Europe Merid., iv., 1826, p. 240.

741—**lachryma** Sowerby, Conch. Illustr., 1837, p. 17, f. 48; Smith, Proc. Malac. Soc., ix., 1910, p. 17; E. denticulata, Pritchard & Gatliff, 1901.

742—**sulcifera** Sowerby, Conch. Illustr., 1837, p. 17, f. 46; E. corrugata, Angas, Proc. Zool. Soc., 1877, p. 182.

Angas erroneously reported (Proc. Zool. Soc., 1877, p. 182) E. angistoma from outside Sydney Heads.

OVULA, Bruguière, Encycl. Meth. vers (1), 1789, p. xv.

743—**brevis** Sowerby, Species Conch., 1830, p. 5, f. 26, 27; Angas, Proc. Zool. Soc., 1871, p. 95.

744—**bulla** Adams & Reeve, Samarang Zool., 1850, p. 21, pl. 6, f. 5; Angas, Proc. Zool. Soc., 1871, p. 94.

745—**dentata** Adams & Reeve, Samarang Zool., 1850, p. 21, pl. 6, f. 4.

746—**ovum** Linné, Bulla, Syst. Nat., x., 1758, p. 725; Sowerby, Thes. Conch., ii., 1849, p. 467, pl. 99, f. 1, 2; Angas, Proc. Zool. Soc., 1877, p. 186.

747—**punctata** Duclos, Mag. Zool., 1830, p. 7, pl. 7, f. 1; Angas, Proc. Zool. Soc., 1877, p. 186.

748—**pyriformis** Sowerby, Zool. Journ., iv., 1828, p. 151, Thes. Conch., ii., 1849, p. 470, pl. 101, f. 72, 73.

749—**volva** Linné, Bulla, Syst. Nat., x., 1758, p. 725; Sowerby, Thes. Conch., ii., 1849, p. 482, pl. 99, f. 6-8; Angas, Proc. Zool. Soc., 1877, p. 186.

RADIUS, Montfort, Conch. Syst., ii., 1810, p. 626.

750—**angasi** Reeve, Ovulum, Conch. Icon., xv., 1865, pl. 10, f. 43; Angas, Proc. Zool. Soc., 1867, p. 207.

751—**hordaceus** Lamarck, Ovula, An. s. vert., vii., 1822, p. 369; Chenu, Man. Conch., i., 1859, p. 272, f. 1778; Angas, Proc. Zool. Soc., 1867, p. 207.

752—**philippinarum** Sowerby, Ovula, Proc. Zool. Soc., 1848, p. 136, and Thes. Conch., ii., 1849, p. 481, pl. 100, f. 57, 58; Angas, Proc. Zool. Soc., 1877, p. 186.

PEDICULARIA, Swainson, Malacology, 1840, p. 245.

753—**stylasteris**, Hedley, Mem. Austr. Mus., iv., 1903, p. 342, f. 69, 70.

Sub-Order STENOGLOSSA (754-989).

Family VOLUTIDÆ.

SCAPHELLA, Swainson, Zool. Illustr., ii., 1832, pl. 87.

754—**moslemica** Hedley, Rec. Austr. Mus., viii., 1912, p. 145, pl. 43, f. 29, 30.

755—**undulata** Lamarck, Voluta, Ann. Mus. Hist. Nat., v., 1804, p. 157, pl. 12, f. 1; V. angasi, Brazier, Proc. Roy. Soc. Tasm., 1876, p. 170.

756—**zebra** Leach, Voluta, Zool. Miscell., l., 1814, p. 31, pl. 12, f. 1; Angas, Proc. Zool. Soc., 1871, p. 88.

CYMBIOLA, Swainson, Zool. Illustr., ii., 1832, pl. 33.

757—**magnifica** Perry, Conchology, Voluta, 1811, pl. 18, f. 1.

758—**marmorata** Swainson, Voluta, Exot. Conch., 1821, pl. 1.

759—**punctata** Swainson, Voluta, Zool. Illustr. (i. ser.), 1823, pl. 161; Cox, Proc. Zool., Soc., 1871, p. 324, pl. 34, f. 6.

ERICUSA, H. & A. Adams, Genera Rec. Moll., ii., 1858, p. 619.

760—**papillosa kenyoniana** Brazier, Voluta, P.L.S.N.S.W. xxii., 1898, p. 779; Verco, Trans. Roy. Soc. S.A., xxxvi., 1912, p. 228, pl. 14, f. 1-3.

761—**sowerbyi** Kiener, Voluta, Coq. Viv., 1839, p. 47, pl. 1; V. fusiformis Angas, Proc. Zool. Soc., 1871, p. 88; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 724.

LIVONIA, Gray, Brit. Mus. Cat. Volut., 1855, p. 8.

762—**mamilla** Sowerby, Voluta, Thes. Conch., i., 1844, p. 207, pl. 1, f. 57, 58.

763—**roadnightæ** McCoy, Voluta, Ann. Mag. Nat. Hist., 1881 (5), viii., p. 88, pl. 7.

LYRIA, Gray, Proc. Zool. Soc., 1847, p. 141.

764—**deliciosa** Montrouzier, Voluta, Journ. de Conch., vii., 1859, p. 375; viii., 1860, p. 121, pl. 2, f. 7, 8; xiv., 1866, p. 355; V. brazieri, Smith, Proc. Malac., Soc., vi., 1904, p. 178, fig.

765—**pattersonia** Perry, Voluta, Conchology, 1811, pl. 17, f. 1; L. nucleus, Petterd, Journ. of Conch., ii., 1879, p. 344.

Family OLIVIDÆ.

OLIVA, Bruguiére, Encycl. Meth. vers, i., 1789, p. xv.

766—**sericea miniacea** Bolten, Mus. Bolt., 1798, p. 33, for Martini Conch. Cab., iii., 1777, pl. 45, f. 476, 477; O. erythrostoma, Angas, Proc. Zool. Soc., 1877, p. 180.

OLIVELLA, Swainson, Zool. Illustr., ii., 1831, pl. 13.

767—**exquisita** Angas, Proc. Zool. Soc., 1871, p. 13, pl. 1, f. 2.

768—**leucozona** Adams & Angas, Proc. Zool. Soc., 1863, p. 422, pl. 37, f. 23.

768a—**leucozona brazieri** Angas, Proc. Zool. Soc., 1877, p. 172, pl. 26, f. 6.

769—**nympha** Adams & Angas, Proc. Zool. Soc., 1863, p. 422; Marrat, Thes. Conch., iv., 1871, p. 37, bis, pl. 350, f. 426.

770—**triticea** Duclos, Monog. Oliva, 1835, pl. 1, f. 5, 6; O. pardalis, Adams & Angas, Proc. Zool. Soc., 1863, p. 422, pl. 37, f. 3.

ANCILLA, Lamarck, Mem. Soc. Hist. Nat. Paris, 1799, p. 70.

771—**cingulata** Sowerby, Ancillaria, Spec. Conch., 1830, p. 6, pl. 13, f. 36, 37; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 301.
Amalda angasi, Cox, nom. nud. Exchange List, 1868, p. 6.

772—**edithæ** Pritchard & Gatliff, Proc. Roy. Soc. Vict., xi., 1899, p. 181, pl. 20, f. 5; Hedley, P.L.S.N.S.W. xli., 1917, p. 709.

773—**oblonga** Sowerby, Ancillaria, Spec. Conch., 1830, p. 7, f. 38,; Hedley, Mem. Austr. Mus., iv., 1903, p. 364.

Angas has misreported A. marginata from Sydney (Proc. Zool. Soc., 1867, p. 192).

Family MARGINELLIDÆ.

MARGINELLA, Lamarck, Mem. Soc. N. H. Paris, 1799, p. 70.

774—**agapeta** Watson, Chall. Zool., xv., 1886, p. 266, pl. 16, f. 9.

775—**angasi** Crosse, Journ. de Conch., xviii., 1870, p. 304; Hedley, P.L.S.N.S.W., xxxix, 1915, p. 726, pl. 82, f. 66; M. minima, Petterd, Journ. of Conch., iv., 1884, p. 144; M. simsoni, Tate & May, Trans. Roy. Soc. S.A., xxiv., 1900, p. 92; M. shorehami, Pritchard & Gatliff, Proc. Roy. Soc. Vict., xi., 1899, p. 179, pl. 20, f. 2.

776—**brazieri** Smith, Proc. Zool. Soc., 1891, p. 440, pl. 34, f. 14.

777—**carinata** Smith, Proc. Zool. Soc., 1891, p. 440, pl. 34, f. 13.

778—**cratericula** Tate & May, Trans. Roy. Soc. S.A., xxiv., 1900, p. 91, and P.L.S.N.S.W., xxvi., 1901, p. 363, pl. 26, f. 74; Hedley, Mem. Austr. Mus., iv., 1903, p. 369.

779—**geminata** Hedley, Rec. Austr. Mus., viii., 1912, p. 145, pl. 42, f. 28.

780—**inconspicua** Sowerby, Thes. Conch., i., 1846, p. 387, pl. 75, f. 80; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 726, pl. 82, f. 64.

781—**johnstoni** Petterd, Journ. of Conch., iv., 1884, p. 143.

782—**kemblensis** Hedley, Mem. Austr. Mus., iv., 1903, p. 365, f. 88.

783—**malina** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 725, pl. 82, f. 65.

784—**mayii** Tate, Trans. Roy. Soc. S.A., xxiv., 1900, p. 93, and P.L.S.N.S.W., xxvi, 1901, p. 362, pl. xxvii., f. 84; xxvii., 1902, p. 19.

785—**multiplicata** Tate & May, Trans. Roy. Soc. S.A., xxiv., 1900, p. 91, and P.L.S.N.S.W., xxvi., 1901, p. 364, pl. 27, f. 84.

786—**muscaria** Lamarck, An. s. vert., vii., 1822, p. 359; Chenu, Illustr. Conch., 1850, pl. 2, f. 3; Angas, Proc. Zool. Soc., 1867, p. 196.

787—**mustellina** Angas, Proc. Zool. Soc., 1871, p. 14, pl. 1, f. 5; Hedley, P.L.S.N.S.W., xli., 1917, p. 709, pl. 50, f. 31.

788—**nympha** Brazier, P.L.S.N.S.W., xix., 1894, p. 168, pl. 14, f. 2.

789—**ochracea**, Angas, Proc. Zool. Soc., 1871, p. 14, pl. 1, f. 6; M. metcalfei, Angas, Proc. Zool. Soc., 1877, p. 173, pl. 26, f. 9; Smith, Journ. of Malac., xi., 1904, p. 31.

790—**olivella** Reeve, Conch. Icon., xv., 1865, pl. 25, f. 140.

791—**infelix** Jousseaume, Rev. Mag. Zool. (3), iii., 1875, p. 238; procella May, Proc. Roy. Soc. Tasm., 1915, p. 87, pl. 2, f. 10.

792—**ovulum** Sowerby, Thes. Conch., i., 1846, p. 401, pl. 78, f. 188; Angas, Proc. Zool. Soc., 1867, p. 196; May, Proc. Roy. Soc. Tasm., 1915, p. 82.

793—**pumilio** Tate & May, P.L.S.N.S.W., xxvi., 1901, p. 363, pl. 26, f. 79; Hedley, Mem. Austr. Mus., iv., 1903, p. 368.

794—**stilla** Hedley, Mem. Austr. Mus., iv., 1903, p. 367, f. 90.

795—**strangei**, Angas, Proc. Zool. Soc., 1877, p. 172, pl. 26, f. 8; Hedley, P.L.S.N.S.W., xxvii., 1902, p. 18, text fig.

796—**subbulbosa** Tate, Trans. Roy. Soc. S.A., i., 1878, p. 86; Hedley, P.L.S.N.S.W., xxvii., 1902, p. 18, text fig.

797—**translucida** Sowerby, Thes. Conch., i., 1846, p. 376, pl. 75, f. 62, 63; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 725, pl. 82, f. 67.

798—**turbinata** Sowerby, Thes. Conch., i., 1846, p. 385, pl. 75, f. 70, 71; Watson, Chall. Zool., xv., 1886, p. 265.

799—**victoriæ** Gatliff & Gabriel, Proc. Roy. Soc. Vict., xxi., 1908, p. 365, pl. 21, f. 5; Hedley, P.L.S.-N.S.W., xxxix., 1915, p. 726.

800—**whani** Pritchard & Gatliff, Proc. Roy. Soc. Vict., xiii., 1900, p. 137, pl. 21, f. 5, 6; Hedley, Mem. Austr. Mus., iv., 1903, p. 369.

Reeve erroneously recorded (vide P.L.S.N.S.W., xxxviii., 1913, p. 303) M. attenuata from Sydney. Brazier misidentified (P.L.S.N.S.W, xviii., 1894, p. 305) Mar-

ginella pulchella Kiener, from Sydney. And M. kemblensis taken by the Challenger in 25 fathoms off Sydney was by Angas (Proc. Zool. Soc., 1877, p. 182) mistaken for M. rufula, Gaskoin.

Family CANCELLARIDÆ.

CANCELLARIA, Lamarck, Mem. Soc. N.H. Paris, 1799, p. 71.

801—**antiquata** Hinds, Sulphur Zool., 1844, p. 43, pl. 12, f. 17, 18; Angas, Proc. Zool. Soc., 1877, p. 186.

802—**australis** Sowerby, Conch. Illustr., 1832, f. 23; C. undulata Sowerby, Proc. Zool. Soc., 1848, p. 136; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 304.

803—**costifera** Sowerby, Conch. Illustr., 1832, f. 31; Angas, Proc. Zool, Soc., 1877, p. 186.

804—**exigua** Smith, Proc. Zool. Soc., 1891, p. 439, pl. 34, f. 11.

To New South Wales, its author erroneously attributes Cancellaria lævigata, Sowerby, Thes. Conch., ii., 1849, p. 448.

ADMETE, Moller, Naturhist. Tidskr., iv., 1842, p. 88.

805—**micra scobina** Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 222, pl. 38, f. 12; vi., 1907, p. 360.

806—**stricta** Hedley, Rec. Austr. Mus., vi., 1907, p. 295, pl. 54, f. 10.

Family TEREBRIDÆ.

TEREBRA, Lamarck, Mem. Soc. Hist. Nat. Paris, 1799, p. 71.

807—**bicolor** Angas, Acus, Proc. Zool. Soc., 1867, p. 111, pl. 13, f. 7.

808—**brazieri** Angas, Proc. Zool. Soc., 1871, p. 16, pl. 1, f. 15.

809—**fictilis** Hinds, Thes. Conch., i., 1844, p. 183, pl. 45, f. 109, 110; Hedley, P.L.S.N.S.W., xxv., 1900, p. 509, pl. 26, f. 14; A. assimilis, Angas, Proc. Zool. Soc., 1867, p. 111, pl. 13, f. 8.

810—**lauretanæ** Ten. Woods, P.L.S.N.S.W., ii., 1877 (1878), p. 262; Hedley & Petterd, Rec. Austr. Mus., iv., 1906, p. 222, pl. 37, f. 9.

811—**marmorata** Deshayes, Proc. Zool. Soc., 1859, p. 279; Reeve, Conch. Icon., xii., 1860, pl. 19, f. 91; Angas, Proc. Zool. Soc., 1877, p. 185.

812—**triseriata** Gray, Proc. Zool. Soc., 1834, p. 62; Thes. Conch., i., 1844, p. 171, pl. 45, f. 119; Dall, Bull. Mus. Comp. Zool., xliii., 1908, p. 248; T. prælonga, Deshayes, Proc. Zool. Soc., 1859, p. 315.

813—**venila** Ten. Woods, P.L.S.N.S.W., iv., 1879, p. 23, pl. 4, f. 2; Tryon, Man. Conch., vii., 1885, p. 21, pl. 5, f. 88.

DUPLICARIA Dall, Nautilus, xxii., 1908, p. 125.

814—**ballina** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 729, pl. 84, f. 86.

815—**vallesia** Hedley, Rec. Austr. Mus., viii., 1912, p. 147, pl. 43, f. 31, and P.L.S.N.S.W., xxxviii., 1913, p. 306.

Angas has erroneously recorded (Proc. Zool. Soc., 1877, p. 185) Acus spectabilis Hinds from the Redbank River.

PARVITEREBRA, Pilsbry, Proc. Acad. N. Sci. Philad., 1904, p. 5.

816—**brazieri** Angas, Euryta, Proc. Zool. Soc., 1875, p. 390, pl. 45, f. 5; Mangelia harrissoni, Ten. Woods, Proc. Roy. Soc., 1877, p. 890.

817—**trilineata** Adams & Angas, Euryta, Proc. Zool. Soc., 1863, p. 418, pl. 37, f. 13.

Family CONIDÆ.

CONUS, Linné, Syst. Nat., x., 1758, p. 712.

818—**angasi** Tryon, Man. Conch., vi., 1884, p. 62, pl. 19, f. 99; C. sydneyensis, Sowerby, Thes. Conch., v., 1887, p. 260, pl. 510, f. 694; C. metcalfei Angas (not Reeve, 1843), Proc. Zool. Soc., 1877, p. 173, pl. 26, f. 13.

819—**aplustre** Reeve, Conch., Icon., i., 1843, pl. 30, f. 170; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 308; C. cookii, Brazier, Proc. Zool. Soc., 1870, p. 109.

820—**capitaneus** Linné, Syst. Nat., x., 1758, p. 713; Reeve, Conch. Icon., i., 1843, pl. 11, f. 54; Hedley, P.L.S.N.S.W., xxvi., 1902, p. 631; Voluta zonaria Martyn, Univ. Conch., 1787, pl. 129.

821—**coronatus** Gmelin, Syst. Nat., xiii., 1791, p. 3389; Hedley, P.L.S.N.S.W., xli., 1917, p. 709; C. minimus Sowerby, Thes. Conch., iii., 1853, pl. 189, f. 54, 55.

822—**cyanostoma** Adams, Proc. Zool. Soc., 1853 (1854), p. 116; Hedley, P.L.S.N.S.W, xxxviii., 1913, p. 309; C. innotabilis, Smith, Proc. Zool. Soc., 1891, p. 487, pl. 40, f. 1.

823—**maculosus** Sowerby, Thes. Conch., iii., 1859, p. 31, pl. 199, f. 296; C. jukesii, Reeve, Conch. Icon., i., suppl., 1848, pl. 2, f. 278; C. rossiteri Brazier, Proc. Zool. Soc., 1870, p. 109.

824—**rutilus** Menke, Spm. Moll. Nov. Holl., 1843, p. 27; C. smithi Angas, Proc. Zool. Soc., 1877, p. 36, pl. 5, f. 8.

Angas has erroneously recorded (Proc. Zool. Soc., 1867, p. 205) Conus grayi from Middle Harbour.

Family TURRIDÆ.

A detailed account of Australian Turridæ, now in preparation is anticipated by a declaration of the following new generic names:—

AUSTRODRILLIA, Hedley, 1918, type, Pleurotoma angasi Crosse, 1863.

EPIDEIRA, Hedley, 1918, type, Clavatula striata, Gray, 1827.

ETREMA, Hedley, 1918, type, Glyphostoma aliciae Melv. Stand, 1895.

EXOMILUS, Hedley, 1918, type, Mangelia lutaria Hedley, 1907.

GURALEUS, Hedley, 1918, type, Mangelia picta Ad. & Ang., 1864.

HEMIDAPHNE, Hedley, 1918, type, Pleurotoma, souverbiei, Smith, 1882.

INQUISITOR, Hedley, 1918, type, Pleurotoma sterrha Watson, 1881.

MACTEOLA, Hedley, 1918, type, Purpura anomala, Angas, 1877.

NEPOTILLA, Hedley, 1918, type, Daphnella bathentoma Verco, 1909.

SCABRELLA, Hedley, 1918, type, Daphnella versivestita Hedley, 1912.

COLUMBARIUM, von Martens, Conch. Mittheil. Bd., ii., 1881, p. 105.

825—**pagodoides** Watson, Fusus, Chall. Zool., xv., 1886, p. 197, pl. 14, f. 3.

LEUCOSYRINX, Dall, Bull. Mus. Comp. Zool., xvii., 1889, p. 75.

826—**casearia** Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 220, pl. 37, f. 5.

827—**recta** Hedley, Mem. Austr. Mus., iv., 1903, p. 386, f. 99.

BATHYTOMA, Harris & Burrows, Eocene and Olig. Paris Basin, 1891, p. 113.

828—**agnatum** Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 220, pl. 37, f. 3.

829—**biconicum** Hedley, Mem. Austr. Mus., iv., 1903, p. 385, f. 98.

APATURRIS, Iredale, Proc. Malac. Soc., xii., 1917, p. 329.

830—**brazieri** Smith, Mitromorpha, Proc. Zool. Soc., 1891, p. 487, pl. 40, f. 2.

831—**sarcinula** Hedley, Bathytoma, Rec. Austr. Mus., vi., 1905, p. 53, f. 21.

GURALEUS, Hedley, 1918.

832—**brazieri** Angas, Clathurella, Proc. Zool. Soc., 1871, p. 18, pl. 1, f. 21.

833—**flavescens** Angas, Mangelia, Proc. Zool. Soc., 1877, p. 37, pl. 5, f. 11.

834—**kingensis** Petterd, Daphnella, Journ. of Conch., ii., 1879, p. 102; var. emina Hedley, Rec. Austr. Mus., vi., 1905, p. 53, f. 20; M. schoutenensis May, Proc. Roy. Soc. Tasm., 1910 (1911), p. 393, pl. 15, f. 19.

835—**letourneuxianus** Crosse & Fischer, Pleurotoma, Journ. de Conch., xiii., 1865, p. 425, pl. 11, f. 7.

836—**mitralis** Adams & Angas, Bela, Proc. Zool. Soc., 1863, p. 420, 1867, p. 202; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 310, pl. 19, f. 75.

837—**pictus** Adams & Angas, Mangilia, Proc. Zool. Soc., 1863 (1864), p. 419, pl. 37, f. 7; M. vincentina, Crosse & Fischer, Journ. de Conch., xiii., 1865, p. 422, pl. 11, f. 6; Angas, Proc. Zool. Soc., 1877, p. 185.

838—**tasmanicus** Ten. Woods, Cythara, Proc. Roy. Soc., Tasm., 1875 (1876), p. 145; M. jacksonensis Angas, Proc. Zool. Soc., 1877, p. 37, pl. 5, f. 10.

PSEUDORHAPHITOMA, Boettger, Nachr. Malak. Gesell. xxvii., 1895, p. 56.

839—**alticostatum** Sowerby, Mangilia, Proc. Malac. Soc., ii., 1896, p. 31, pl. 3, f. 16; Hedley, P.L.S. N.S.W., xxvi., 1901, p. 17.

840—**granulosissimum** Ten. Woods, Clathurella, Proc. Roy. Soc. Tasm., 1878 (1879), p. 37; Tate & May, P.L.S.N.S.W., xxvi., 1901, p. 370, pl. 24, f. 34; Hedley, Mem. Austr. Mus., iv., 1903, p. 393.

841—**tenuiliratum** Angas, Clathurella, Proc. Zool. Soc., 1871, p. 17, pl. 1, f. 18.

EXOMILUS, Hedley, 1918.

842—**lutarius** Hedley, Mangelia, Rec. Austr. Mus., vi., 1907, p. 296, pl. 54, f. 11, 12.

843—**pentagonalis** Verco, Trans. Roy. Soc. S.A., xx., 1916, p. 222, pl. 7, f. 2; Hedley, Rec. Austr. Mus., vi., 1907, p. 298.

AUSTRODRILLIA, Hedley, 1918.

844—**angasi** Crosse, Pleurotoma, Journ. de Conch., xi., 1863, p. 87, pl. 1, f. 5.

845—**beraudiana** Crosse, Pleurotoma, Journ. de Conch., xi., 1863, p. 88, pl. 1, f. 6.

846—**nenia** Hedley, Drillia, Mem. Austr. Mus., iv., 1903, p. 387, f. 101.

847—**woodsi** Beddome, Drillia, Proc. Roy. Soc. Tasm., 1882 (1883), p. 167; Hedley, Mem. Austr. Mus., iv., 1903, p. 388.

INQUISITOR, Hedley, 1918.

848—**coxi**, Angas, Drillia, Proc. Zool. Soc., 1867, p. 113, pl. 13, f. 15; D. spadix, Watson, Chall. Zool, xv., 1886, p. 310, pl. 26, f. 6.

849—**metcalfei** Angas, Drillia, Proc. Zool. Soc., 1867, p. 113, pl. 13, f. 16.

850—**multiliratus** Smith, Ann. Mag. Nat. Hist. (4), xix., 1877, p. 469; Hedley, Mem. Austr. Mus., iv., 1903, p. 389, f. 103.

851—**suavis** Smith, Drillia, Ann. Mag. Nat. Hist. (6), ii., 1888, p. 305; D. prosuavis Hedley, Mem. Austr. Mus., iv., 1903, p. 389, f. 102; Sykes, Proc. Malac. Soc., vi., 1904, p. 130.

852—**tricarinatus**, Ten. Woods Drillia, P.L.S.N.S.W., ii., 1878, p. 265; Hedley Mem. Austr. Mus., iv., 1903, p. 389, f. 104.

EUCITHARA, Fischer, Man. Conch., 1883, p. 593.

853—**compta** Adams & Angas, Cithara, Proc. Zool. Soc., 1863, p. 419, pl. 37, f. 5.

PSEUDODAPHNELLA, Boettger, Nachr. Malak. Gesell. xxvii., 1895, p. 58.

854—**modesta** Angas, Clathurella, Proc. Zool. Soc., 1877, p. 38, pl. 5, f. 15.

855—**pustulata** Angas, Clathurella, Proc. Zool. Soc., 1877, p. 38, pl. 5, f. 14.

856—**rufozonata** Angas, Clathurella, Proc. Zool. Soc., 1877, p. 38, pl. 5, f. 13.

EPIDEIRA, Hedley, 1918.

857—**striata** Gray, Clavatula, Append. King Survey, ii., 1827, p. 485; P. oweni, Reeve, Conch. Icon., i., 1845, pl. 9, f. 70.

858—**xanthophaes** Watson. Chall. Rep. xv., 1886, p. 282, pl. 26, f. 1.

MACTEOLA, Hedley, 1918.

859—**anomala** Angas, Purpura, Proc. Zool. Soc., 1877, p. 34, pl. 5, f. 1.

ETREMA, Hedley, 1918.

860—**alliterata** Hedley, Glyphostoma, P.L.S.N.S.W., xxxix., 1915, p. 728, pl. 82, f. 56, 57.

861—**bicolor** Angas, Clathurella, Proc. Zool. Soc., 1871, p. 18, pl. 1, f. 20; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 729, pl. 82, f. 60–61.

862—**nassoides** Reeve, Pleurotoma, Conch. Icon., i., 1845, pl. 29, f. 259; C. zonulata Angas, Proc. Zool. Soc., 1867, p. 113, pl. 13, f. 17.

ASTHENOTOMA, Harris and Burrows, Eoc. and Oligo., Paris Basin, 1891, p. 113.

863—**cognata** Smith, Pleurotoma, Ann. Mag. Nat. Hist. (4), xix., 1877, p. 490; Hedley, P.L.S.N.S.W., xxxviii., 1908, p. 487, pl. 10, bis. f. 2.

864—**dilecta** Hedley, Drillia, Mem. Austr. Mus., iv., 1903, p. 387, f. 100.

865—**subtilinea**, Hedley, 1918, for Pleurotoma violacea, Angas (not Hinds), Proc. Zool. Soc., 1871, p. 92.

PARACLATHURELLA, Boettger, Nach. Malak. Gesell., xxvii., 1895, p. 56.

866—**bilineata** Angas, Clathurella, Proc. Zool. Soc., 1871, p. 18, pl. 1, f. 23.

DAPHNELLA, Hinds, Sulphur Zool., 1844, p. 25.

867—**aculeola** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 728, pl. 82, f. 58.

868—**boholensis** Reeve, Pleurotoma, Conch. Icon., i., 1843, pl. 13, f. 112.

869—**botanica** Hedley, nom, nov., 1918, Pleurotoma fragilis, Reeve, Conch. Icon., i., 1845, pl. 21, f. 179, not Deshayes, 1834.

870—**edwini** Brazier, Pleurotoma, P.L.S.N.S.W., xix., 1894, p. 168, pl. 14, f. 3.

HEMIDAPHNE, Hedley, 1918.

870a—**souverbiei** Smith, Pleurotoma, Ann. Mag. Nat. Hist. (5), x., 1882, p. 300; Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 488, pl. vii., fig. 9.

NEPOTILLA, Hedley, 1918.

871—**bathentoma** Verco, Daphnella, Trans. Roy. Soc. S.A., xxxiii., 1909, p. 326, pl. 28, f. 3.

872—**excavata** Gatliff, Daphnella, Proc. Roy. Soc. Vict., xix., 1906, p. 1, pl. 1, f. 1–2.

SCABRELLA, Hedley, 1918.

873—**albocincta** Angas, Clathurella, Proc. Zool. Soc., 1871, p. 18, pl. 1, f. 22.

874—**brenchleyi** Angas, Clathurella, Proc. Zool. Soc., 1877, p. 37, pl. 5, f. 12.

875—**hayesiana** Angas, Clathurella, Proc. Zool. Soc., 1871, p. 17, pl. 1, f. 17.

876—**sculptilis** Angas, Clathurella, Proc. Zool. Soc., 1871, p. 17, pl. 1, f. 19.

877—**versivestita**, Hedley, Daphnella, Rec. Austr. Mus., viii., 1912, p. 148, pl. 43, f. 33.

878—**vestalis** Hedley, Daphnella, Mem. Austr. Mus., iv., 1903, p. 390, f. 105.

VEPRECULA, Melvill, Proc. Malac. Soc., xii., 1917, pp. 141–188.

879—**vepratica** Hedley, Mem. Austr. Mus., iv., 1903, p. 384, f. 97.

MANGILIA, Auctorum. Unclassified.

880—**hilum** Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 471, pl. 9, f. 17.

881—**spica** Hedley, Rec. Austr. Mus., vi., 1907, p. 297, pl. 55, f. 20.

882—**hoylei** Smith, Proc. Zool. Soc., 1891, p. 439, pl. 34, f. 9.

883—**challengeri** Smith, op. cit. p. 438, pl. 34, f. 7.

884—**crossei** Smith, op. cit., p. 439, pl. 34, f. 8.

885—**watsoni** Smith, op. cit., p. 439, pl. 34, f. 10.

885–I—**fastosa** Hedley, Rec. Austr. Mus., vi., 1907, p. 295, pl. 55, f. 21.

Adams and Angas (Proc. Zool. Soc., 1863, p. 420) have erroneously reported from Port Jackson, Clathurella reticosta (= purpurea Blainville) vide P.L.S.N.S.W., xxxiii., 1906, p. 459. From Middle Harbour Angas (Proc. Zool. Soc., 1867, p. 203), misidentified Daphnella limnæformis. He also erred in reporting (Proc. Zool. Soc., 1865, p. 160) Pleurotoma lallemantiana from Port Jackson. Also in error, he recorded (Proc. Zool. Soc., 1871, p. 92) Pleurotoma violacea from Broken Bay. Further he was mistaken (Proc. Zool. Soc., 1867, p. 202) in reporting Drillia radula from Port Jackson. Again, Drillia æmula does not occur in New South Wales, as he supposed (Proc. Zool. Soc., 1877, p. 86).

Family FASCIOLARIIDÆ.

FASCIOLARIA, Lamarck, Mem. Soc. N. Hist. Paris, 1799, p. 73.

886—**australasia** Perry, Pyrula, Conchology, 1811, pl. 54, f. 4. Hedley, Mem. Austr. Mus., iv., 1903, p. 373.

886a—**australasia bakeri** Gatliff & Gabriel, Vict. Nat. xxix, 1912, p. 47, pl. 3, lower figures.

886b—**australasia coronata** Lamarck, An. s. vert., vii., 1822, p. 120; Kiener, Coq. Viv., 1840, pl. 9, f. 1.

LATIROFUSUS, Cossmann, Ann. Soc. Roy. Malac. Belg., xxiv., 1889, p. 175.

887—**spiceri** Ten. Woods, Fusus, Proc. Roy. Soc. Tasm., 1876 (1877), p. 137; L. nigrofuscus Tate, Trans. Roy. Soc. S.A., xiv., 1891, p. 258, pl. 2, f. 3.

VERCONELLA, Iredale, Proc. Malac. Soc., xi., 1914, p. 175.

888—**maxima** Tryon, Siphonalia, Man. Conch., iii., 1881, p. 135, pl. 54, f. 355; Hedley, Mem. Austr. Mus., iv., 1903, p. 374, pl. 38.

FUSINUS, Rafinesque, Anal. Nat., 1815, p. 145.

889—**novæhollandiæ** Reeve, Fusus, Conch. Icon., iv., 1848, pl. 18, f. 70; Angas, Proc. Zool. Soc., 1877, p. 179.

890—**turrispictus** Martyn, Buccinum, Univ. Conch., 1786, f. 90; Fusus laticostatus, Angas, Proc. Zool. Soc., 1877, p. 179; = F. variegatus, Perry, 1811, = F. oblitus, Reeve, 1847.

891—**waitei** Hedley, Fusus, Mem. Austr. Mus., iv., 1903, p. 373, pl. 37.

A. Adams has erroneously reported (Proc. Zool. Soc., 1854, p. 316) Latirus strangei from Sydney.

Family MITRIDÆ.

MITRA, Martyn, Univ. Conch., 1784, Expl. to pl. 19.

892—**acromialis** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 730, pl. 84, f. 85.

893—**carbonaria** Swainson, Bligh Cat. Append., 1822, p. 10; Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 461, and xxxviii., 1913, p. 312.

894—**cookii** Sowerby, Thes. Conch., iv., 1874, p. 7, pl. 354, f. 228; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 314.

895—**glabra** Swainson, Exot. Conch., i., 1821, pl. 24; Angas, Proc. Zool. Soc., 1871, p. 89.

896—**legrandi** Ten. Woods, Proc. Roy. Soc. Tasm., 1875 (1876), p. 140; Hedley, Rec. Austr. Mus., iii., 1900, p. 219, text fig. and P.L.S., N.S.W., xxxviii., 1913, p. 314.

897—**miranda** Smith, Proc. Zool. Soc., 1891, p. 440, pl. 34, f. 12.

898—**nodostaminea** Hedley, Rec. Austr. Mus., viii., 1912, p. 150, pl. 43, f. 35.

899—**pacifica** Reeve, Proc. Zool. Soc., 1845, p. 52; Sowerby, Thes. Conch., iv., 1874, p. 27, pl. 370, f. 388; Brazier, P.L.S.N.S.W., iv., 1880, p. 429.

900—**rhodia** Reeve, Conch. Icon., ii., 1845, pl. 28, f. 225; Hedley, P.L.S.N.S.W., xli., 1917, p. 711, pl. 48, f. 15, 16.

901—**solida** Reeve, Conch. Icon., ii., 1844, pl. 3, f. 18; Forbes, Voy. Rattlesnake, ii., 1852, p. 365.

902—**strangei** Angas, Proc. Zool. Soc., 1867, p. 110, pl. 13, f. 4.

903—**volucra** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 730, pl. 84, f. 84.

Angas (Proc. Zool. Soc., 1871, p. 89) erroneously quoted Mitra variabilis Reeve from Sydney.

MICROVOLUTA, Angas, Proc. Zool. Soc., 1877, p. 34; ? Paradmete, Strebel, 1908.

904—**australis** Angas, op. cit., p. 35, pl. 5, f. 2; Hedley, Mem. Austr. Mus., iv., 1903, p. 371.

Family BUCCINDÆ.

CADUCIFER, Dall, Smithson. Miscell. Coll., xlviii., 1904, pl. 136.

905—**antiquata** Hinds, Triton, Proc. Zool. Soc., 1844, p. 21; T. coxi, Brazier, Proc. Zool. Soc., 1872, p. 22, pl. 4, f. 9; Hedley, P.L.S.N.S.W., xxxii., 1907, p. 508.

COMINELLA, H. & A. Adams, Genera. Rec. Moll., i., 1853, p. 110.

906—**alveolata** Kiener, Buccinum, Coq. Viv., 1834, p. 31, pl. 10, f. 34; Angas, Proc. Zool. Soc., 1877, p. 180.

907—**filicea** Crosse & Fischer, Journ. de Conch., xii., 1864, p. 346, and xiii., 1865, p. 49, pl. 3, f. 15, 16.

Angas has erroneously recorded (Proc. Zool. Soc., 1867, p. 189) C. adelaidensis from Middle Harbour. C. costata was erroneously recorded by Schmeltz (fide Brazier, P.L.S.N.S.W., iv., 1880, p. 390) from Sydney.

NODOPELAGIA, Hedley, P.L.S.N.S.W., xxxix., 1914, p. 731.

908—**brazieri** Angas, Peristernia, Proc. Zool. Soc., 1877, p. 171, pl. 26, f. 4.

CYLLENE, Griffiths & Pidgeon, Mollusca, 1833, p. 597, pl. 41.

909—**delicatula** Sowerby, Pisania, Journ. of Malac., viii., 1901, p. 101, pl. 9, f. 2; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 316.

910—**lactea** Adams & Angas, Proc. Zool. Soc., 1863, p. 422; Hedley, P.L.S.N.S.W., xxvi., 1901, p. 19, pl. 2, f. 10.

Sowerby erroneously recorded (vide Hedley, P.L.S.-N.S.W., xxxviii., 1913, p. 316) Phos terebra from Sydney.

EUTHRIA, Gray, Fig. Moll. Anim., iv., 1850, p. 67.

911—**tabida** Hedley, Phos., P.L.S.N.S.W., xxix., 1904, p. 191, pl. 8, f. 18.

Family FUSIDÆ.

FUSUS, Helbling, Abh. Privatges. Bohmen., iv., 1779, p. 116.

912—**brazieri** Angas, Triton, Proc. Zool. Soc., 1869, p. 46, pl. 2, f. 3.

913—**schoutanicus** May, Pisania, Proc. Roy. Soc. Tasm., 1910 (1911), p. 389, pl. 14, f. 14.

MACULOTRITON, Dall. Smithson. Miscell. Coll., xlvii., 1904, p. 136.

914—**australis** Pease, Cantharus, Am. Journ. Conch., vii., 1872, p. 21; Tryon, Man. Conch., iii., 1881, p. 160, pl. 73, f. 269; Hedley, P.L.S.N.S.W., xli., 1917, p. 711, pl. 50, f. 28–30.

915—**bracteatus** Hinds, Triton, Proc. Zool. Soc., 1844, p. 21; Clathurella waterhouseæ, Brazier, P.L.S.-N.S.W., xxi., 1896, p. 345; Hedley, op. cit., xxiv., 1899, p. 434, f. 7; xxx., 1906, p. 529.

916—**gracilis** Sowerby, Phos, Thes. Conch., iii., 1859, p. 91, pl. 222, f. 33; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 733, pl. 84, f. 79.

917—**unicolor** Angas, Cantharus, Proc. Zool. Soc., 1867, p. 110, pl. 13, f. 2.

Angas erroneously recorded Cantharus assimilis Reeve from Sydney (vide P.L.S.N.S.W., xxxiii., 1908, p. 459).

FASCINUS, Hedley, Mem. Austr. Mus., iv., 1903, p. 375.

918—**typicus** Hedley, op. cit., p. 376, f. 91.

Nassaria curta Gould, from Port Jackson, cannot now be recognised (P.L.S.N.S.W., xxxviii., 1913, p. 317).

Family NASSARIIDÆ.

NASSARIUS, Froriep in Dumeril, Zool. Analyt., 1806, p. 167; Iredale, Proc. Malac. Soc., xii., 1916, p. 82.

919—**burchardi** Philippi, Buccinum, Abbild. Beschr., iii., 1849, p. 69, pl. 2, f. 14.

920—**coronatus** Bruguiére, Buccinum, Encycl. Meth., vers. (1), 1789, p. 277; Reeve, Conch. Icon., viii., 1853, pl. 3, f. 20; Brazier, P.L.S.N.S.W., iv., 1880, p. 428.

921—**dipsacoides** Hedley, Arcularia, Rec. Austr. Mus., vi., 1907, p. 359, pl. 67, f. 21.

922—**gemmulatus** Lamarck, Buccinum, Anim. s. vert., vii., 1822, p. 271; Encycl. Meth., ver., 1816, pl. 394, f. 4; Angas, Proc. Zool. Soc., 1877, p. 180.

923—**jonasi** Dunker, Buccinum, Zeit. Malak., iii., 1846, p. 171; Philippi, Abbild. Beschr., 1849, iii., p. 66, pl. 2, f. 10; Hedley, Journ. Roy. Soc., N.S.W., xlix., 1915, p. 52, f. 16; Nassa labecula, Adams, Proc. Zool. Soc., 1851 (1852), p. 98.

924—**muricatus** Quoy & Gaim., Buccinum, Astrolabe Zool., ii., 1833, p. 450, pl. 32, f. 32–33.

925—**particeps** Hedley, Arcularia, P.L.S.N.S.W., xxxix., 1915, p. 738, and xli., 1917, p. 712, pl. 49, f. 20.

926—**pauperus** Gould, Nassa, Proc. Boston Nat. Hist. Soc., iii., 1850, p. 155, and U.S. Expl. Exped., xii., p. 262, pl. 19, f. 330.

927—**pauperatus** Lamarck, Buccinum, Anim. s. vert., vii., 1822, p. 278; Quoy & Gaim., Astrolabe Zool., ii., 1833, p. 439, pl. 32, f. 5–7; Angas, Proc. Zool. Soc., 1867, p. 190.

928—**peritrema** Ten. Woods, Nassa, P.L.S.N.S.W., iv., 1880, p. 21, pl. 4, f. 5.

929—**semigranosus** Dunker, Buccinum, Zeitschr. Malak., iii., 1846, p. 170; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 735, pl. 83, f. 78.

929a—**semigranosus nigellus** Reeve, Conch. Icon., viii., 1854, pl. 26, f. 173.

930—**spiratus** Adams, Nassa, Proc. Zool. Soc., 1851 (1852), p. 106; Reeve, Conch. Icon., viii., 1853, pl. 2, f. 13; Angas, Proc. Zool. Soc., 1877, p. 180.

Nassa decussata was erroneously recorded by A. Adams from Brisbane Water (Hedley, P.L.S.N.S.W.,

xxxviii., 1913, p. 317). Frauenfeld erroneously recorded (Novara Zool., 1867, Moll., p. 5) Nassa intermedia from Sydney. Nassa reposta was described by Gould (Proc. Boston Soc. Nat. Hist., viii., 1860, p. 323) from Sydney. The type is lost, and the species unrecognisable. Angas erroneously recorded (Proc. Zool. Soc., 1867, p. 190) Nassa rufocincta and N. jacksoniana from New South Wales.

Family PYRENIDÆ.

PYRENE, Bolten, Mus. Bolt., 1798, p. 134.

931—**acleonta** Duclos, Columbella, Monogr., 1840, pl. 11, f. 3, 4; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 321.

932—**alizonæ** Melvill & Standen, Proc. Zool. Soc., 1901, p. 402, pl. 21, f. 5; Hedley, op. cit., p. 321.

933—**australis** Gaskoin, Columbella, Proc. Zool. Soc., 1851 (1852), p. 5; Reeve, Conch. Icon., xi., 1858, Columbella, pl. 15, f. 78.

934—**babylonica** Hedley, Rec. Austr. Mus., vi., 1907, p. 358, pl. 67, f. 16.

935—**beddomei** Petterd, Terebra, Journ. of Conch., iv., 1884, p. 142; C. attenuata, Angas (not Beyrich), Proc. Zool. Soc., 1871, p. 14, pl. 1, f. 4.

936—**filmeræ** Sowerby, Columbella, Proc. Malac. Soc., iv., 1900, p. 3, pl. 1, f. 8; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 319.

937—**intexta** Gaskoin, Columbella, Proc. Zool. Soc., 1851 (1852), p. 7; Reeve, Conch. Icon., xi., 1858, pl. 17, f. 88.

938—**leucostoma** Gaskoin, Columbella, Proc. Zool. Soc., 1851 (1852), p. 4; Reeve, Conch. Icon., xi., 1859, pl. 34, f. 220.

939—**lincolnensis** Reeve, Columbella, Conch. Icon., xi., 1859, pl. 29, f. 184; Angas, Proc. Zool. Soc., 1867, p. 195.

940—**peroniana** Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 318; C. bicincta, Angas (not Gould), Proc. Zool. Soc., 1871, p. 14, pl. 1, f. 3.

941—**puella** Sowerby, Columbella, Proc. Zool. Soc., 1844, p. 52; Reeve, Conch. Icon., xi., 1858, pl. 13, f. 65; Watson, Chall. Zool., xv., 1886, p. 235.

942—**pulla** Gaskoin, Columbella, Proc. Zool. Soc., 1851 (1852), p. 6; Reeve, Conch. Icon., xi., 1858, pl. 19, f. 106; Angas, Proc. Zool. Soc., 1867, p. 195.

943—**semiconvexa** Lamarck, Buccinum, An. s. vert., vii., 1822, p. 272; Kiener, Coq. Viv., 1834, p. 49, pl. 18, f. 60; Angas, Proc. Zool. Soc., 1867, p. 194.

944—**tayloriana** Reeve, Columbella, Conch. Icon., xi., 1859, pl. 35, f. 225; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 320; C. albomaculata, Angas, Proc. Zool. Soc., 1867, p. 111, pl. 13, f. 5.

945—**tyleræ** Griffiths & Pidgeon, Columbella, Anim. Kingdom, xii., 1834, p. 596, pl. 37, f. 1; Angas, Proc. Zool. Soc., 1877, p. 181.

946—**versicolor** Sowerby, Columbella, Proc. Zool. Soc., 1832, p. 119; and Thes. Conch., i., 1844, p. 117, bis pl. 37, f. 41; Angas, Proc. Zool. Soc., 1867, p. 194; var. **atladona** Duclos, Hist. Nat. Coq. Univ., 1835, pl. 1, f. 11, 12.

PSEUDAMYCLA, Pace, Proc. Malac. Soc., v., 1902, p. 255.

947—**dermestoidea** Lamarck, Buccinum, An. s. vert., vii., 1822, p. 275; Kiener, Coq. Viv., 1834, p. 52, pl. 25, f. 100; Pace, op. cit., p. 235, fig.; C. lineata, Brazier, 1877.

ÆSOPUS, Gould, Proc. Boston Soc. Nat. Hist., vii., 1860, p. 383.

948—**australis** Angas, Truncaria, Proc. Zool. Soc., 1877, p. 172, pl. 26, f. 5.

948a—**cassandra** Hedley, Daphnella, P.L.S.N.S.W., xxix., 1904, p. 187, pl. 8, f. 17.

948b—**pallidulus** Hedley, Mitromorpha, P.L.S.N.S.W., xxx., 1906, p. 534, pl. 32, f. 26.

949—**plurisulcatus** Reeve, Columbella, Conch. Icon., xi., 1859, pl. 36, f. 233; Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 457; Æ. filosa, Angas, Proc. Zool. Soc., 1867, p. 111, pl. 13, f. 6.

ZAFRA, Adams, Ann. Nat. Hist. (3), vi., 1860, p. 331.

950—**atkinsoni** Ten. Woods, Mangelia, Proc. Roy. Soc. Tasm., 1876 (1877), p. 141; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 744, pl. 83, f. 72.

950a—**atkinsoni speciosa** Angas, Columbella, Proc. Zool. Soc., 1877, p. 35, pl. 5, f. 3.

951—**avicennia** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 742, pl. 83, f. 68, 69.

952—**fulgida** Reeve, Columbella, Conch. Icon., xi., 1859, pl. 28, f. 178; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 325; C. interrupta, Angas, 1865; C. angasi, Brazier, 1871.

953—**lurida** Hedley, Pyrene, P.L.S.N.S.W., xxxii., 1907, p. 510, pl. 17, f. 19.

954—**smithi** Angas, Columbella, Proc. Zool. Soc., 1877, p. 172, pl. 26, f. 7; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 742, pl. 83, f. 75.

RETIZAFRA, Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 326.

955—**plexa** Hedley, Columbella, P.L.S.N.S.W., xxvi., 1901, p. 702, f. 25.

Family MURICIDÆ.

MUREX, Linné, Syst. Nat., x., 1758, p. 746.

956—**acanthopterus** Lamarck, Encycl. Meth., vers., 1816, pl. 417, f. 2; Angas, Proc. Zool. Soc., 1867, p. 186.

957—**angasi** Crosse, Typhis, Journ. de Conch., xi., 1863, p. 86, pl. 1, f. 2.

958—**brazieri** Angas, Proc. Zool. Soc., 1877, p. 171, pl. 26, f. 3.

959—**damicornis** Hedley, Mem. Austr. Mus., iv., 1903, p. 378, f. 92.

960—**denudatus** Perry, Triplex, Conchology, 1811, pl. 7, f. 2; M. palmiferus, Angas, Proc. Zool. Soc., 1867, p. 186.

961—**patagiatus** Hedley, Rec. Austr. Mus., viii., 1912, p. 151, pl. 43, f. 36.

Angas has erroneously recorded (Proc. Zool. Soc., 1877, p. 179) Murex cervicornis as from off Montagu Island.

TROPHON, Montfort, Syst. Conch., ii., 1810, p. 482.

962—**carduelis** Watson, Chall. Zool., xv., 1886, p. 167, pl. 10, f. 7.

963—**columnarius** Hedley & May, Rec. Austr. Mus., vii., 1908, p. 121, pl. 24, f. 22.

964—**goldsteini** Ten. Woods, Proc. Roy. Soc. Tasm., 1875 (1876), p. 136; Verco Trans. Roy. Soc., S.A., xix., 1895, p. 97, pl. 1, f. 4, 5; Hedley, P.L.S.-N.S.W., xxvii., 1902, p. 18.

965—**laminatus** Petterd, Journ. of Conch., iv., 1884, p. 136; Tate & May, P.L.S.N.S.W., xxvi., 1901, p. 352, pl. 23, f. 3; Hedley, Mem. Austr. Mus., iv., 1903, p. 379.

966—**licinus** Hedley & Petterd, Murex, Rec. Austr. Mus., vi., 1906, p. 219, pl. 37, f. 6.

967—**petterdi** Crosse, Journ. de Conch., xviii., 1870, p. 303, and xix., 1871, p. 324, pl. 12, f. 2; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 327.

968—**rudolphi** Brazier, Peristernia, P.L.S.N.S.W., xix., 1894, p. 166, pl. 14, f. 1.

969—**simplex** Hedley, Mem. Austr. Mus., iv., 1903, p. 380, f. 93.

970—**stimuleus** Hedley, Rec. Austr. Mus., vi., 1907, p. 293, pl. 55, f. 19.

CRASPEDOTRITON, Dall, Smithson. Miscell. Coll., xlvii., 1904, p. 119.

971—**speciosus** Angas, Triton, Proc. Zool. Soc., 1871, p. 13, pl. 1, f. 7; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 327.

ASPELLA, Morch, Mal. Blatt., xxiv., 1877, p. 24.

972—**anceps** Lamarck, Ranella, An. s. vert., vii., 1822, p. 154; Kiener, Coq. Viv., 1842, p. 36, pl. 4, f. 2; Angas, Proc. Zool. Soc., 1877, p. 180.

973—**undata** Hedley, Rec. Austr. Mus., vi., 1907, p. 294, pl. 55, f. 15.

LATAXIENA, Jousseaume, Bull. Soc. Zool., viii., 1883, p. 183.

974—**imbricata** Smith, Fusus, Journ. Linn. Soc. Zool., xii., 1876, p. 540, pl. 30, f. 3.

TYPHIS, Montfort, Conch. Syst., ii., 1810, p. 614.

975—**phillipensis** Watson, Chall. Zool., xv., 1886, p. 162, pl. 10, f. 4; Hedley, Mem. Austr. Mus., iv., 1903, p. 382.

976—**syringianus** Hedley, Mem. Austr. Mus., iv., 1903, p. 381, f. 94.

XYMENE, Iredale, Trans. N.Z. Inst., xlvii., 1914 (1915), p. 471.

977—**contracta** Reeve, Buccinum, Conch. Icon., iii., 1846, pl. 8, f. 53.

978—**hanleyi** Angas, Trophon, Proc. Zool. Soc., 1867, p. 110, pl. 13, f. 1; Hedley, P.L.S.N.S.W., xli., 1917, p. 712, pl. 49, f. 21–24.

Family THAIDIDÆ.

THAIS, Bolten, Mus. Bolt., 1798, p. 54.

979—**ambustulata** Hedley, Rec. Austr. Mus., viii., 1912, p. 152, pl. 44, f. 37.

980—**succincta** Martyn, Buccinum, Univ. Conch., 1784, pl. 45; Hedley, P.L.S.N.S.W., xxx., 1906, p. 533, pl. 33, f. 31, 32, and Journ. Roy. Soc. N.S.W., xlix., 1915, p. 57, f. 19; Kesteven, P.L.S.N.S.W., xxvi., 1902, p. 538, pl. 29, f. 1, 8.

Brazier has erroneously reported (P.L.S.N.S.W., v., 1880, p. 481) Polytropa striata from Sydney. Angas has erroneously reported (Proc. Zool. Soc., 1867, p. 191) Purpura amygdala from Sydney.

AGNEWIA, Ten. Woods, Proc. Roy. Soc. Tasm., 1877 (1878), p. 29.

981—**pseudamygdala** Hedley, Purpura, P.L.S.N.S.W., xxvii., 1903, p. 599, pl. 29, f. 4, 5.

982—**tritoniformis** Blainville, Purpura, Nouv. Ann. Mus., i., 1832, p. 221, pl. 10, f. 10; Kesteven, P.L.S.-N.S.W., xxvi., 1902, p. 533–8, pl. 29, f. 2–7; Adamsia typica, Angas, Proc. Zool. Soc., 1867, p. 192; ? Cheletropis huxleyi, Forbes Voy. Rattlesnake, ii., 1852, p. 385, pl. 3, f. 9.

LEPSIELLA, Iredale, Trans. N.Z. Inst., xlvii., 1914 (1915), p. 474.

983—**botanica** nom. nov. for neglecta Angas, Purpura, Proc. Zool. Soc., 1867, p. 110, pl. 13, f. 3; Kesteven, P.L.S.N.S.W., xxvi., 1902, p. 714, pl. 36, f. 2; not P. neglecta, Michelotti, Nat. Verh. Holland, ii., pl. 3, sect. 2, p. 219, 1847, fide T. Iredale.

984—**vinosa propinqua** Ten. Woods, Purpura, Proc. Roy. Soc. Tasm., 1875 (1876), p. 135; Hedley, P.L.S.-N.S.W., xxxviii., 1913, p. 330, and xxxix., 1915, p. 746, pl. 85, f. 88.

PROVEXILLUM, nom. nov. for Vexilla Swainson, Malac., 1840, p. 300, not Vexillum, Bolten, Mus. Bolt., 1798, p. 138.

985—**vexillum** Gmelin, Strombus, Syst. Nat., xiii., 1791, p. 3520; Reeve, Conch. Icon., iii., Buccinum, 1846, pl. 10, f. 79; Hedley, P.L.S.N.S.W., xxvi., 1902, p. 631.

RAPANA, Schumacher, Nouv. Syst., 1817, p. 214.

986—**nodosa** Adams, Proc. Zool. Soc., 1853 (1854), p. 98; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 331, pl. 19, f. 80.

CORALLIOPHILA, H. & A. Adams, Gen. Rec. Moll., i., 1853, p. 135.

987—**lischkeana** Dunker, Rapana, Index, Moll. Mar. Jap. 1882, p. 43, pl. 1, f. 1, 2, pl. 13, f. 26, 27; Purpura sertata, Hedley, Mem. Austr. Mus., iv., 1903, p. 382, f. 95, 96.

DRUPA, Bolten, Mus. Bolt., 1798, p. 55.

988—**chaidea** Duclos, Purpura, Ann. Sci. Nat., xxvi., 1832, p. 106, pl. 1, f. 4; Angas, Proc. Zool. Soc., 1867, p. 191.

989—**marginalba** Blainville, Purpura, Nouv. Ann. Mus. (3), i., 1832, p. 219, pl. 10, f. 6; Kiener, Coq. Viv. Purpura, 1835, p. 24, pl. 5, f. 11.

Angas has incorrectly recorded (Proc. Zool. Soc., 1877, p. 180) Ricinula adelaidensis from Jervis Bay.

Sub-Order PULMONATA (990–1003).

Family ELLOBIIDÆ.

RHODOSTOMA, Swainson, Proc. Roy. Soc., V.D. Land, iii., 1855, p. 44.

990—**zonatum** Adams, Cassidula, Proc. Zool. Soc., 1854, (1855), p. 32; Hedley, P.L.S.N.S.W., xxx., 1906, p. 537, pl. 33, f. 30.

MARINULA, King, Zool. Journ., v., 1835, p. 343.

991—**xanthostoma** Adams, Proc. Zool. Soc., 1854 (1855), p. 35; Hedley, P.L.S.N.S.W., xxvi., 1902, p. 704, pl. 34, f. 18; Connolly, Ann. S. Afric. Mus., xiii., 1915, p. 116.

PHYTIA, Gray, London Medical Repository, xv., 1821, p. 231.

992—**ornata** Ferussac, Auricula, Tab. Syst., 1821, p. 103; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 334, and xli., 1917, p. 714, pl. 50, f. 26, 27; A. australis, Quoy & Gaim., Astrolabe Zool., ii., 1833; p. 169, pl. 13, f. 34, 38.

993—**sulcata** Adams, Laimodonta, Proc. Zool. Soc., 1854 (1855), p. 34; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 333, pl. 19, f. 86.

Angas recorded, perhaps erroneously (Proc. Zool. Soc., 1867, p. 231) Ophicardelus quoyi from Port Jackson.

PLECOTREMA, H. & A. Adams, Proc. Zool. Soc., 1853 (1854), p. 120.

994—**lirata** H. & A. Adams, op. cit., p. 121; Cox, P.L.S.-N.S.W., xviii., 1894, p. 423, f. .

LEUCONOPSIS, Hutton, Trans. N.Z. Inst., xvi., 1883 (1884), p. 213.

995—**inermis** Hedley, P.L.S.N.S.W., xxv., 1901, p. 722, pl. 48, f. 15.

Family ONCHIDIIDÆ.

ONCIS, Plate, Zool. Jahrb., vii., Anat., 1894, p. 164.

996—**chameleon** Brazier, Onchidium, P.L.S.N.S.W., x., 1886, p. 729.

Family AMPHIBOLIDÆ.

SALINATOR, Hedley, P.L.S.N.S.W., xxv., 1900, p. 511.

997—**fragilis** Lamarck, Ampullaria, An. s. vert., vi., 1822, p. 179; Quoy & Gaim., Astrolabe Zool., ii., 1833, p. 201, p. 15, f. 10–16.

Family SIPHONARIIDÆ.

SIPHONARIA, Sowerby, Genera Shells, 1824, fasc. xxi.

998—**bifurcata** Reeve, Conch. Icon., ix., 1856, pl. 5, f. 22.

999—**scabra** Reeve, Conch. Icon., ix., 1856, pl. 1, f. 2; Hedley, P.L.S.N.S.W., xli., 1917, p. 715, pl. 50, f. 32.

1000—**virgulata** Hedley, P.L.S.N.S.W., xxxix., 1915, p. 751, pl. 85, f. 96, 97, 98.

1001—**zebra** Reeve, Conch. Icon., ix., 1856, pl. 5, f. 21.

From New South Wales, Angas has erroneously recorded (Proc. Zool. Soc., 1867, p. 232) S. atra, cochleariformis, denticulata and funiculata.

KERGUELENIA, Mabille & Rochefort, Miss. Scient. Cap. Horn, 1889, p. H. 27.

1002—**stowæ** Verco, Trans. Roy. Soc. S.A., xxx., 1906, p. 223, pl. 8, f. 3–8.

GADINIA, Gray, Philos. Mag., lxiii., 1824, p. 274.

1003—**conica** Angas, Proc. Zool. Soc., 1867, p. 115, pl. 13, f. 27; Iredale, Proc. Malac. Soc., ix., 1910, p. 78.

Sub-Order OPISTHOBRANCHIA (1004–1161).

Family ACTEONIDÆ.

ACTEON, Montfort, Conch. Syst., ii., 1810, p. 314.

1004—**austrinus** Watson, Chall. Zool., xv., 1886, p. 628, pl. 47, f. 2; Hedley, Mem. Austr. Mus., iv., 1903, p. 393.

1005—**roseus** Hedley, P.L.S.N.S.W., xxx., 1906, p. 535, pl. 33, f. 42.

PUPA, Bolten, Mus. Bolt., 1798, p. 110.

1006—**affinis** Adams, Solidula, Proc. Zool. Soc., 1854 (1855), p. 61; Watson, Chall. Zool., xv., 1886, p. 630, pl. 47, f. 1.

1007—**coccinata** Reeve, Tornatella, Proc. Zool. Soc., 1842, p. 60; Brazier, P.L.S.N.S.W., iv., 1879 (1880), p. 429.

1008—**nivea** Angas, Buccinulus, Proc. Zool. Soc., 1871, p. 19, pl. 1, f. 27.

LEUCOTINA, Adams, Ann. Mag. Nat. Hist. (3), v., 1860, p. 406.

1009—**amœna** Adams, Monoptygma, Proc. Zool. Soc., 1851 (1853), p. 223; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 335.

1010—**australis** Angas, Agatha, Proc. Zool. Soc., 1871, p. 15, pl. 1, f. 19.

1011—**concinna** Adams, Monoptygma, Thes. Conch., ii., 1854, p. 819, pl. 172, f. 34; Dall & Bartsch, Proc. Nat. Museum, xxx., 1906, p. 329, pl. 19, f. 5; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 336.

1012—**micra** Pritchard & Gatliff, Turbonilla, Proc. Roy. Soc. Vict., xiii., 1900, p. 134, pl. 21, f. 1; Hedley, P.L.S.N.S.W., xxix., 1904, p. 187.

1013—**pura** Adams, Monoptygma, Thes. Conch., ii., 1854, p. 820, pl. 172, f. 23; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 335; L. esther, Angas.

1014—**speciosa** Adams, Monoptygma, Thes. Conch., ii., 1854, p. 818, pl. 172, f. 24–25.

1015—**sinuata** Angas, Myonia, Proc. Zool. Soc., 1877, p. 39, pl. 5, f. 18.

CINGULINA, Adams, Ann. Mag. Nat. Hist. (3), vi., 1860, p. 414.

1016—**diaphana** Verco, Trans. Roy. Soc., S.A., xxx., 1906, p. 143, pl. 4, f. 11.

1017—**circinata** Adams, Ann. Mag. Nat. Hist (3), vi., 1860, p. 414; Dall & Bartsch, Proc. Nat. Mus., xxx., 1906, p. 359, pl. 33, f. 6; C. brazieri, Angas, Proc. Zool. Soc., 1877, pl. 5, f. 5, p. 35; ? Chemnitzia circumdata, Gould, Proc. Boston. Soc. Nat., vii., 1861, p. 401; Terebra hedleyi, Smith, P.L.S.-N.S.W., xxix., 1904, p. 211.

1018—**spina** Crosse & Fischer, Turritella, Journ. de Conch., xii., 1864, p. 347, and xiii., 1865, p. 44, pl. 3, f. 13–14; Angas, Proc. Zool. Soc., 1871, p. 91; Smith, Proc. Zool. Soc., 1890, p. 278.

MATHILDA, Semper, Journ. de Conch., xiii., 1865, p. 330.

1019—**decorata** Hedley, Mem. Austr. Mus., iv., 1903, p. 352, f. 75.

1020—**rosæ** Hedley, P.L.S.N.S.W., xxv., 1901, p. 721, pl. 48, f. 13–14.

1021—**elegantula** Angas, Proc. Zool. Soc., 1871, p. 15, pl. 1, f. 8.

Family PYRAMIDELLIDÆ.

SYRNOLA, Adams, Ann. Mag. Nat. Hist. (3), v., 1860, p. 405.

1022—**aurantiaca** Angas, Styloptygma, Proc. Zool. Soc., 1867, p. 112, pl. 13, f. 14.

1023—**bifasciata** Ten. Woods, Obeliscus, Proc. Roy. Soc., Tasm., 1875 (1876), p. 145; O. jucundus, Angas, Proc. Zool. Soc., 1877, p. 173, pl. 26, f. 10.

1024—**macrocephala** Hedley, Mem. Austr. Mus., iv., 1903, p. 362, f. 85.
1025—**manifesta** Hedley, Rec. Austr. Mus., viii., 1912, p. 143, pl. 42, f. 23–24.
1026—**tincta** Angas, Proc. Zool. Soc., 1871, p. 15, pl. 1, f. 11.

OSCILLA, Adams, Proc. Zool. Soc., 1867, p. 310.

1027—**tasmanica** Ten. Woods, Parthenia, Proc. Roy. Soc., Tasmania, 1876 (Feb., 1877), p. 34; O. ligata, Angas, Proc. Zool. Soc., 1877, Aug., p. 173, pl. 26, f. 11.

MYXA, Hedley, Mem. Austr. Mus., iv., 1903, p. 362.

1028—**exesa** Hedley, op. cit., p. 363, f. 86.

ODOSTOMIA, Fleming, Edinb. Encycl., vii., 1813, p. 76.

1029—**angasi** Tryon, Man. Conch., viii., 1886, p. 362, pl. 79, f. 68; O. lactea, Angas (not Dunker, preoc.), Proc. Zool. Soc., 1867, p. 112, pl. 13, f. 11.
1030—**australis** Angas, Agatha, Proc. Zool. Soc., 1871, p. 15, pl. 1, f. 9.
1031—**henni** Brazier, P.L.S.N.S.W., xix., 1894, p. 171, pl. 14, f. 8; P. perspectiva Hedley, P.L.S.N.S.W., xxvii., 1902, p. 10, pl. 3, f. 33.
1032—**ignava** Hedley, P.L.S.N.S.W., xxxiii., 1908, p. 470, pl. 10, f. 32.
1033—**indistincta** Brazier, P.L.S.N.S.W., xix., 1894, p. 171, pl. 14, f. 7.
1034—**lævis** Angas, Proc. Zool. Soc., 1867, p. 112, pl. 13, f. 10.
1035—**nugatoria** Hedley, Mem. Austr. Mus., iv., 1903, p. 363, f. 87.
1036—**opaca** Hedley, P.L.S.N.S.W., xxx., 1906, p. 524, pl. 33, f. 41.
1037—**pascoei** Angas, Proc. Zool. Soc., 1867, p. 112, pl. 13, f. 12; O. kreffti, Angas, op. cit., f. 13; Hedley, P.L.S.N.S.W., xli., 1917, p. 716, pl. 46, f. 5.
1038—**portseaensis** Gatliff & Gabriel, Turbonilla, Proc. Roy. Soc., Vict., xxiv., 1911, p. 188, pl. 46, f. 1.
1039—**simplex** Angas, Proc. Zool. Soc., 1871, p. 15, pl. 1, f. 10.
1040—**suprasculpta** Ten. Woods, Rissoina, Proc. Roy. Soc., Vict., xiv., 1877 (1878), p. 57; Tate & May, P.L.S.N.S.W., xxvi., 1901, p. 383, pl. 26, f. 68.

STYLOPSIS, Adams, Ann. Mag. Nat. Hist. (3), v., 1860, p. 406.

1041—**pulchellus** De Folin, Les Fonds de la Mer, i., 1870, p. 261, pl. 24, f. 2.

TIBERIA, Monterosato, Atti Acc. Palermo, 1875, p. 5.

1042—**nitidula** Adams, Syrnola, Ann. Mag. Nat. Hist., 1860 (3), vi., p. 335; Hedley & Petterd, Rec. Austr. Mus., vi., 1906, p. 216, pl. 38, f. 13.

1043—**pusilla jacksonensis** Dall & Bartsch, Proc. Nat. Museum, xxx., 1906, p. 325, pl. 26, f. 8.

TURBONILLA, Risso, Hist. Nat. Eur. Merid., 1826, p. 224.

1044—**beddomei** Petterd, Chemnitzia, Journ. of Conch., iv., 1884, p. 136; T. scalarina, Brazier, P.L.S.-N.S.W., xix., 1894, p. 170, pl. 14, f. 5; Gatliff & Gabriel, Proc. Roy. Soc., Vict., xxiv., 1911, p. 195.

1045—**brevis** Pritchard & Gatliff, Proc. Roy. Soc., Vict., xiii., 1900, p. 135, pl. 21, f. 4.

1046—**consanguinea** Smith, Proc. Zool. Soc., 1891, p. 441, pl. 35, f. 17.

1047—**constricta** Smith, op. cit., p. 441, pl. 35, f. 8.

1048—**fischeri** Smith, op. cit., p. 441, pl. 35, f. 16.

1049—**fusca** Adams, Chemnitzia, Proc. Zool. Soc., 1853 (1855), p. 181; T. festiva, Angas, Proc. Zool. Soc., 1877, p. 35, pl. 5, f. 4; T. admiranda, Tate & May, Trans. Roy. Soc., S.A., xxiv., 1900, p. 98.

1050—**hofmani** Angas, Proc. Zool. Soc., 1877, p. 183; Tryon, Man. Conch., viii., p. 334, pl. 76, f. 41; T. nitida, Angas, Proc. Zool. Soc., 1867, p. 112, pl. 13, f. 9.

1051—**mariæ** Ten. Woods, Proc. Roy. Soc., Tasm., 1875 (1876), p. 144; Tryon, Man. Conch., viii., 1886, p. 334, pl. 76, f. 42; Whitelegge, Journ. Roy. Soc., N.S.W., xxiii., 1889, p. 263.

1052—**scalpidens** Watson, Chall. Zool., xv., 1886, p. 489, pl. 32, f. 1; Hedley, Mem. Austr. Mus., iv., 1903, p. 362, f. 84.

1053—**varicifera** Tate, Trans. Roy. Soc., S.A., xxii., 1898, p. 85, pl. 4, bis f. 7; Hedley, Rec. Austr. Mus., vi., 1905, p. 42.

Family STROMBIFORMIDÆ.

EULIMA, Risso, Hist. Nat. Eur. Merid., 1826, p. 123.

1054—**articulata** Sowerby, Proc. Zool. Soc., 1834, p. 8, and Conch. Illustr., f. 12; Mort, P.L.S.N.S.W., xxviii., 1903, p. 312.

1055—**coxi** Pilsbry, Proc. Acad. Nat. Sci., Philad., 1899, p. 258, pl. 11, f. 3, 4.

1056—**fricata** Hedley, Rec. Austr. Mus., vi., 1907, p. 290, pl. 55, f. 14.

1057—**mucronata** Sowerby, Conch. Icon., xv., 1866, pl. 6, f. 42.

1058—**munita** Hedley, Mem. Austr. Mus., iv., 1903, p. 358, f. 81.

1059—**proxima** Sowerby, Conch. Icon., xv., 1866, pl. 6, f. 48; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 295.

MELANELLA, Bowdich, Element Conchology, 1822, p. 27.

1060—**commensalis** Tate, Eulima, Trans. Roy. Soc., S.A., xxii., 1898, p. 82, pl. 4, bis f. 2; Hedley, Mem. Austr. Mus., iv., 1903, p. 359.

1061—**petterdi** Beddome, Eulima, Proc. Roy. Soc., Tasm., 1882 (1883), p. 168; E. indiscreta, Tate, Trans. Roy. Soc., S.A., xxii., 1898, p. 82, pl. 4, bis f. 3.

STROMBIFORMIS, Da Costa, Brit. Conchology, 1778, p. 107; Iredale, Proc. Malac. Soc., xi., 1915, p. 292.

1062—**aciculus** Gould, Stilifer, Proc. Boston. Soc. Nat. Hist., iii., 1849, p. 83; E. vitrea, Adams, Thes. Conch., ii., 1854, p. 799, pl. 169, f. 35; Angas, Proc. Zool. Soc., 1867, p. 201.

1063—**acutissimus** Sowerby, Leiostraca, Conch. Icon., xv., 1866, pl. 2, f. 10; L. lesbia, Angas, Proc. Zool. Soc., 1871, p. 16, pl. 1, f. 14; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 295.

1064—**inustus** Hedley, Leiostraca, P.L.S.N.S.W., xxx., 1906, p. 525, pl. 33, f. 43.

1065—**lodderæ** Hedley, Mem. Austr. Mus., iv., 1903, p. 360, f. 82.

1066—**perexiguus** Tate & May, Rissoa, Trans. Roy. Soc., S.A., xxiv., 1900, p. 100, and P.L.S.N.S.W., xxvi., 1901, p. 394, pl. 23, f. 5.

PSEUDORISSOINA, Tate & May, Trans. Roy. Soc., S.A., xxiv., 1900, p. 98.

1067—**elegans** Hedley, Rec. Austr. Mus., vi., 1905, p. 51, f. 17.

1068—**exigua** Hedley, Mem. Austr. Mus., iv., 1903, p. 361, f. 83.

CHILEUTOMIA, Tate & Cossmann, Journ. Roy. Soc., N.S.W., xxxi., 1898, p. 403.

1069—**anceps** Hedley, Menon, P.L.S.N.S.W., xxv., 1900, pp. 90 and 505, pl. 3, f. 5, 6, 7.

STILIFER, Broderip, Proc. Zool. Soc., 1832, p. 60.

1070—**brazieri** Angas, Proc. Zool. Soc., 1877, p. 173, pl. 26, f. 12.

1071—**lodderæ** Petterd, Journ. of Conch., iv., 1884, p. 140; Hedley, P.L.S.N.S.W., xxv., 1900, p. 92, text fig. ; S. crotaphis, Watson, Chall. Zool., xv., 1886, p. 525, pl. 37, f. 10 (not E. marginata, as indicated P.L.S.N.S.W., xxvi., 1901, p. 381).

1072—**petterdi** Tate & May, Trans. Roy. Soc. S.A., xxiv., 1900, p. 96; Hedley, P.L.S.N.S.W., xxv., 1901, p. 729, f. 27.

Apicalia guentheri, Angas, was erroneously ascribed to New South Wales, vide P.L.S.N.S.W., xxxviii., 1913, p. 296.

EULIMELLA, Forbes, Ann. Nat. Hist., xiv., 1846, p. 412.

1073—**anabathron** Hedley, P.L.S.N.S.W., xxx., 1906, p. 524, pl. 33, f. 39, 40.

1074—**moniliformis** Hedley & Musson, P.L.S.N.S.W., xvi., 1891, p. 247, pl. 19, f. 1–3.

1075—**pulchra** Brazier, P.L.S.N.S.W., xix., 1894, p. 170, pl. 14, f. 6, and xxvii., 1902, p. 18.

1076—**turrita** Petterd, Aclis, Journ. of Conch., iv., 1884, p. 140; Tate & May, P.L.S.N.S.W., xxvi., 1901, p. 384, pl. 25, f. 38; Hedley, Rec. Austr. Mus., vi., 1905, p. 42.

Family ARCHITECTONICIDÆ.

ARCHITECTONICA, Bolten, Mus. Bolt., 1798, p. 78.

1077—**atkinsoni** Smith, Solarium, Proc. Zool. Soc., 1891, p. 441, pl. 35, f. 19.

1078—**layardi** Adams, Philippia, Proc. Zool. Soc., 1854, p. 317; Angas, Proc. Zool Soc., 1871, p. 92.

1079—**lutea** Lamarck, Solarium, An. s. vert., vii., 1822, p. 5; Kiener, Coq. Viv., 1839, p. 9, pl. 4, f. 9; Angas, Proc. Zool. Soc., 1867, p. 201.

1080—**maxima** Philippi, Solarium, Zeit. Malak., v., 1848, p. 170; and Conch. Cab., ii., 1853, p. 6, pl. 1, f. 2, 3.

1081—**perspectiva** Linné, Trochus, Syst. Nat., x., 1758, p. 757; Hanley, Thes. Conch., iii., 1863, p. 228, pl. 253, f. 36–38; Angas, Proc. Zool. Soc., 1877, p. 184.

1082—**reevei** Hanley, Solarium, Proc. Zool. Soc., 1862, p. 204, and Thes. Conch., iii., 1863, p. 234, pl. 250, f. 9–10.

HELIACUS, D'Orbigny, Moll. Cuba, ii., 1841, p. 68.

1083—**crenellus** Linné, Turbo, Syst. Nat., 1758, p. 759; S. chemnitzi, Kiener Coq. Viv., 1839, p. 12, pl. 4, f. 8; T. infundibuliformis, Angas, Proc. Zool. Soc., 1877, p. 184.

1084—**foveolatus** Tate, Torinia, Trans. Roy. Soc. S.A., xvii., 1893, p. 191, pl. 1, f. 13; Hedley, P.L.S.-N.S.W., xxv., 1900, p. 93.

1085—**stamineus** Gmelin, Trochus, Syst. Nat., xiii., 1791, p. 3575; Hanley, Thes. Conch., iii., 1863, p. 242, pl. 254, f. 95–7; Angas, Proc. Zool. Soc., 1871, p. 92.

DISCOHELIX, Dunker, Palæontographia, i., 1847, p. 132.

1086—**meridionalis** Hedley, Omalaxis, Mem. Austr. Mus., iv., 1903, p. 351, f. 74; Iredale, Proc. Malac. Soc., ix., 1911, p. 256.

Family TORNATINIDÆ.

RETUSA, Brown, Illustr. Conch. Gt. Brit., 1827, Expl., pl. 38.

1087—**apicina** Gould, Tornatina, Proc. Boston Soc. Nat. Hist., vii., 1859, p. 139; T. brenchleyi, Angas, Proc. Zool. Soc., 1877, p. 40, pl. 5, f. 20; U. avenarius, Watson, Chall. Zool. xv., 1886, p. 658, pl. 49, f. 5; Hedley, P.L.S.N.S.W., xxxviii., 1913, p. 337.

1088—**exserta** Hedley, Tornatina, Mem. Austr. Mus., iv., 1903, p. 393, f. 108.

1089—**hofmani** Angas, Tornatina, Proc. Zool. Soc., 1877, p. 39, pl. 5, f. 19.

CYLICHNINA, Monterosato, Nom. Gen. spec. medit., 1884, p. 143.

1090—**atkinsoni** Ten. Woods, Cylichna, Proc. Roy. Soc. Tasm., 1876 (1877), p. 156; 1902, p. 113, f. 11.

1091—**iredaleana** Hedley, Retusa, P.L.S.N.S.W., xxxix., 1915, p. 752, pl. 85, f. 93, 94.

Angas erroneously reported (Proc. Zool. Soc., 1867, p. 226) Tornatina fusiformis from Port Jackson.

RHIZORUS, Montfort, Conch. Syst., ii., 1810, p. 338.
1092—**rostratus** Adams, Bulla, Thes. Conch., ii., 1850, p. 596, pl. 125, f. 154; Hedley, Mem. Austr. Mus., iv., 1903, p. 394, f. 109.
1093—**tragula** Hedley, Volvula, Mem. Austr. Mus., iv., 1903, p. 395, f. 110.

Family RINGICULIDÆ.

RINGICULA, Deshayes, An. s. vert. (2), viii., 1838, p. 323.
1094—**denticulata** Gould, Proc. Boston Soc. Nat. Hist., vii., 1860, p. 325; Hedley, P.L.S.N.S.W., xxxix., 1915, p. 753, pl. 85, f. 95.
1095—**doliaris** Gould, op. cit., p. 324; Watson, Chall. Zool., xv., 1886, p. 634, pl. 47, f. 8.

Angas erroneously recorded (Proc. Zool. Soc., 1871, p. 98) R. arctata, R. caron and R. exserta from Sydney.

PUGNUS, Hedley, Rec. Austr. Mus., ii., 1896, p. 106.
1096—**parvus** Hedley, op. cit., p. 106, pl. 23, f. 1; May, Proc. Roy. Soc. Tasm., 1910, p. 311; Oliver, Trans. N.Z. Inst., xlvii., 1914 (1915), p. 542.

Family SCAPHANDRIDÆ.

CYLICHNELLA, Gabb., Proc. Ac. Nat. Sci. Philad., 1872, p. 273.
1097—**arachis** Quoy & Gaimard, Bulla, Astrolabe Zool., ii., 1833, p. 361, pl. 26, f. 28–30.
1098—**elegans** Angas, Cylichna, Proc. Zool. Soc., 1877, p. 175, pl. 26, f. 19.
1099—**ordinaria** Smith, Cylichna, Proc. Zool. Soc., 1891, p. 442, pl. 35, f. 21.
1100—**protumida** Hedley, Mem. Austr. Mus., iv., 1903, p. 396, f. 112.
1101—**tenuis** Hedley, Cylichna, Rec. Austr. Mus., vi., 1905, p. 54, f. 22.
1102—**thetidis** Hedley, Cylichna, Mem. Austr. Mus., iv., 1903, p. 395, f. 111.

Smith has erroneously recorded (Proc. Malac. Soc., i., 1894, p. 60) Scaphander gracilis Watson from 410 fathoms off Sydney.

Family AKERIDÆ.

BULLARIA, Rafinesque, Anal. Nat., 1815, p. 142; Bulla, Linné, Syst. Nat., x., 1758, p. 725, not Bulla, Linné, op. cit., p. 427.

1103—**ampulla** Linné, Bulla, Syst. Nat., x., 1758, p. 727; (?) Watson, Chall. Zool., xv., 1886, p. 637.

1104—**botanica** Hedley, 1918, nom. mut. for B. australis, Gray, Ann. Philos., xxv., 1825, p. 408, not B. australis, Ferussac, Dict. Class. Nat. Hist., iii., 1822, p. 575; Brazier, P.L.S.N.S.W., x., 1885, p. 89.

1105—**incommoda** Smith, Proc. Zool. Soc., 1891, p. 442, pl. 35, f. 20.

1106—**punctulata** A. Adams, Bulla, Thes. Conch., ii., 1850, p. 604; B. ovula, Sowerby, Conch. Icon., xvi., 1868, pl. 2, f. 5; B. solida, Sowerby, op. cit., pl. 4, f. 10; B. magdelus, Angas, Proc. Zool. Soc., 1867, p. 227; B. angasi, Pilsbry, Man. Conch., xv., 1893, p. 347, pl. 36, f. 32, 33.

CYLINDROBULLA, Fischer, Journ de Conch., v., 1856, p. 275.

1107—**fischeri** Adams & Angas, Proc. Zool. Soc., 1864, p. 37; Hedley, P.L.S.N.S.W., xxvii., 1903, p. 604, pl. 29, f. 8, 9.

AKERA, Muller, Zool. Dan. Prod., 1776, p. xxix.

1108—**soluta** Gmelin, Bulla, Syst. Nat., xiii., 1791, p. 3434; Pilsbry, Man. Conch., xv., 1893, p. 378, pl. 42, f. 18.

HAMINŒA, Turton & Kingston, Natural History Teignmouth, 1830; Iredale, Proc. Malac. Soc., xi., 1914, p. 172.

1109—**brevis** Quoy & Gaim, Bulla, Astrolabe Zool., ii., 1833, p. 358, pl. 26, f. 36, 37; Angas, Proc. Zool. Soc., 1867, p. 227.

1110—**crocata** Pease, Proc. Zool. Soc., 1860, p. 19; Sowerby, Conch. Icon., xvi., 1868, pl. 5, f. 29; Angas, Proc. Zool. Soc., 1877, p. 189.

1111—**cuticulifera** Smith, Ann. Mag. Nat. Hist (4), ix., 1872, p. 350, and Alert, Zool., 1884, p. 87, pl. 6, f. H.

1112—**tenera** Adams, Bulla, Thes. Conch., ii., 1850, p. 583, pl. 124, f. 103; Angas, Proc. Zool. Soc., 1871, p. 98.

Family APLUSTRIDÆ.

APLUSTRUM, Schumacher, Essai Nouv. Syst., 1817, p. 63.

1113—**brazieri** Angas, Diaphana, Proc. Zool. Soc., 1877, p. 175, pl. 26, f. 20; Hedley, P.L.S.N.S.W., xxvii., 1902, p. 16, pl. 3, f. 36.

HYDATINA, Schumacher, Essai Nouv. Syst., 1817, p. 57.

1114—**cinctoria** Perry, Conchology, 1811, pl. 40, f. 1; H. albocincta, Angas, Proc. Zool. Soc., 1877, p. 189.

1115—**circulata** Martyn, Bulla, Univ. Conch., 1784, pl. 95.

1116—**exigua** Hedley, Rec. Austr. Mus., viii., 1912, p. 158, pl. 45, f. 46.

1117—**physis** Linné, Bulla, Syst. Nat., x., 1758, p. 727; Sowerby, Thes. Conch., ii., 1850, p. 565, pl. 120, f. 9–11.

BULLINULA, Swainson, Malacology, 1840, p. 360.

1118—**ziczac** Muhlfeldt, Voluta, Ges. Nat. Fr. Berlin, viii., 1818, p. 5; B. lineata, Brazier, P.L.S.N.S.W., x., 1886, p. 92.

MICROMELO, Pilsbry, Man. Conch., xv., 1893, p. 391.

1119—**guamensis** Quoy & Gaim., Bullæa, Zool. Uranie & Physc., 1825, p. 416, pl. 66, f. 10, 11, 12; Henn, P.L.S.N.S.W., xx., 1896, p. 520.

Family PHILINIDÆ.

PHILINE, Ascanius, K. Vet. Ac. Handl., xxxiii., 1772, p. 331.

1120—**angasi** Crosse & Fischer, Bullæa, Journ. de Conch., xiii., 1865, p. 38, pl. 2, f. 8; Hedley, Rec. Austr. Mus., viii., 1912, p. 159, pl. 44, f. 42, 43.

1121—**oscitans** Hedley, Rec. Austr. Mus., vi., 1907, p. 361, pl. 67, f. 17.

1122—**teres** Hedley, Mem. Austr. Mus., iv., 1903, p. 398, f. 113.

1123—**trapezia** Hedley, P.L.S.N.S.W., xxvi., 1902, p. 704, pl. 34, f. 22–24.

Family CAVOLINIDÆ.

CAVOLINA, Abilgaard, Skr. Nat. Selsk., i., 1796, p. 175; Sykes, Proc. Malac. Soc., vii., 1906, p. 5.

1124—**gibbosa** D'Orbigny, Voy. Am. Merid., v., 1836, p. 95, pl. 5, f. 16, 20; Pelseneer, Chall. Zool., xxiii., 1888, p. 82.

1125—**globulosa** Gray, Cat. Moll. Brit. Mus., 1850, p. 8; Pelseneer, op. cit., p. 81.

1126—**inflexa** Lesueur, Hyalæa, Nouv. Bull. Soc. Philom., iii., 1813, pl. 5, f. 3; Pelseneer, op. cit., p. 85.

1127—**longirostris** Blainville, Hyalæa, Dict. Sci. Nat., xxii., 1821, p. 81; Pelseneer, op. cit., p. 79.

1128—**strangulata** Hedley, Rec. Austr. Mus., vi., 1907, p. 299, pl. 54, f. 13; ? C. couthouyi, Dall, Smiths. Miscell. Coll., i., 1908, p. 502; Tesch, Das Tierreich, 1913, p. 44.

1129—**telemus** Linné, Monoculus, Syst. Nat., x., 1758, p. 635; C. tridentata, Pelseneer, op. cit., p. 83.

1130—**uncinata** D'Orbigny, Voy. Am. Merid., v., 1836, p. 93, pl. 5, f. 11, 15; Pelseneer, op. cit., p. 84.

DIACRIA, Gray, Proc. Zool. Soc., 1847, p. 203.

1131—**quadridentata** Blainville, Hyalæa, Dict. Sci. Nat., xxii., 1821, p. 81; Pelseneer, op. cit., p. 78.

1132—**trispinosa** Blainville, op. cit., p. 82; Pelseneer, op. cit., p. 76.

SPIRATELLA, Blainville, Dict. Sci. Nat., ix., 1817, p. 407.

1133—**bulimoides** D'Orbigny, Atlanta, Voy. Am. Merid., v., 1836, p. 179, pl. 12, f. 36–38; Pelseneer, op. cit., p. 30.

1134—**inflata** D'Orbigny, op. cit., p. 17, pl. 2, f. 16, 17; Pelseneer, op. cit., p. 17.

1135—**lesueuri** D'Orbigny, op. cit., p. 177, pl. 20, f. 12–15; Pelseneer, op. cit., p. 24.

1136—**retroversa** Fleming, Mem. Wern. Nat. Hist. Soc., iv., 1823, p. 498, pl. 15, f. 2; Vayssiere, Results Camp. Scient. Monaco, Fasc., xlvii., 1915, p. 142, pl. 8, f. 150–160; L. trochiformis, Hedley, Mem. Austr. Mus., iv., 1903, p. 399.

CLIO, Linné, Syst. Nat., xii., 1767, p. 1094.

1137—**pyramidatus** Linné, op. cit.; Pelseneer, op. cit., p. 63.

CRESEIS, Rang, Ann. Sci. Nat., xiii., 1828, p. 302.

1138—**acicula** Rang, op. cit., p. 318, pl. 17, f. 6; Pelseneer, op. cit., p. 51.

1139—**virgula** Rang, op. cit., p. 316, pl. 17, f. 2; Pelseneer, op. cit., p. 48.

HYALOCYLIS, Fol., Arch. Zool. Exper., iv., 1875, p. 177.

1140—**striata** Rang, Creseis, op. cit., p. 315, pl. 15, f. 7; Pelseneer, op. cit., p. 54.

STYLIOLA, Gray, Proc. Zool. Soc., 1847, p. 203.

1141—**subula** Quoy & Gaim., Cleodora, Ann. Sci. Nat. (1), x., 1827, p. 233, pl. 8D, f. 1–3.

VAGINELLA, Daudin, Bull. Soc. Philom., 1800, p. 145.

1142—**urceolaris** Morch, Cuvieria, Cat. Conch. Kierulf, 1850, p. 32, pl. 1, f. 8; Vayssiere, Results Camp. Scient. Monaco, Fasc. xlvii., 1915, pl. 2, f. 32 bis; Cuvierina columella, Brazier, Cat. Marine Shells Australia, ii., 1892, p. 32.

Family DORIDIIDÆ.

CHELIDONURA, Adams, Thes. Conch., ii., 1850, p. 561.

1143—**adamsi** Angas, Proc. Zool. Soc., 1867, p. 116, pl. 13, f. 32.

Family OXYNŒIDÆ.

OXYNŒ, Rafinesque, Anal. Nat., 1819, p. 143.

1144—**delicatula** G. & H. Nevill, Journ. Asiat. Soc., xxxviii., 1869, p. 67, pl. 13, f. 5; Angas, Proc. Zool. Soc., 1877, p. 190.

Family TETHYDÆ.

TETHYS, Linné, Syst. Nat., x., 1758, p. 653.

1145—**angasi** Sowerby, Aplysia, Conch. Icon., xvii., 1869, pl. 8, f. 35.

1146—**excavata** Sowerby, op. cit., pl. 3, f. 8.

1147—**hyalina** Sowerby, op. cit., pl. 4, f. 13.

1148—**norfolkensis** Sowerby, op. cit., pl. 10, f. 42; Hedley, P.L.S.N.S.W., xxx., 1906, p. 536, pl. 33, f. 33, 34.

1149—**sowerbyi** Pilsbry, Man. Conch., xvi., 1896, p. 101, pl. 57, f. 20, 21.

1150—**sydneyensis** Sowerby, op. cit., pl. 7, f. 31.

NOTARCHUS, Cuvier, Regn. Anim., ii., 1817, p. 398.

1151—**glaucus** Cheeseman, Aclesia, Proc. Zool. Soc., 1878, p. 277, pl. 15, f. 4; Hedley, P.L.S.N.S.W., xxv., 1900, p. 97, pl. 4.

DOLABELLA, Lamarck, Syst. An. s. vert., 1801, p. 62.
1152—**scapula** Martyn, Lepas, Univ. Conch., 1786, pl. 99; Angas, Proc. Zool. Soc., 1867, p. 227.

DOLABRIFERA, Gray, Proc. Zool. Soc., 1847, p. 162.
1153—**brazieri** Sowerby, Proc. Zool. Soc., 1870, p. 250; Hedley, P.L.S.N.S.W., xli., 1917, p. 717, pl. 49, f. 25; D. jacksoniensis, Pilsbry, Man. Conch., xvi., 1896, p. 120, pl. 44, f. 38–41.

Family NOTOBRANCHAEIDÆ.

NOTOBRANCHÆA, Pelseneer, Bull. Sci. Nord. (2), ix., 1886, p. 224.
1154—**inopinata** Pelseneer, Chall. Zool., xix., 1887, p. 40, pl. 3, f. 6.

Family CLIONIDÆ.

CLIONE, Pallas, Spic. Zool., x., 1774, p. 28.
1155—**longicaudata** Souleyet, Bonite Zool., ii., 1852, p. 286, Moll., pl. 14, f. 17–21.

Family PLEUROBRANCHAEIDÆ.

PLEUROBRANCHUS, Cuvier, Ann. Hist. Nat., v., 1804, p. 275.
1156—**angasi** Smith, Alert Zool., 1884, p. 88, pl. 6, f. K.
1157—**maculatus** Quoy & Gaimard, Pleurobranchidium, Astrolabe Zool. ii., 1833, p. 301, pl. 22, f. 11, 14.
1158—**punctatus** Quoy & Gaim., op. cit., p. 299, pl. 22, f. 15–19.

OSCANIUS, Gray, Proc. Zool., Soc., 1847, p. 163.
1159—**hilli** Hedley, P.L.S.N.S.W., xix., 1896, p. 127, pl. 7.

EUSENELOPS, Pilsbry, Man. Conch., xvi., 1896, p. 228.
1160—**luniceps** Cuvier, Pleurobranchus, Regn. Anim. Ed., iii., 1830, p. 59, pl. 14, f. 2; Hedley, P.L.S.N.S.W., xxi., 1896, p. 816; Pace, Proc. Malac. Soc., iv., 1901, p. 202–4, fig.

Family UMBRACULIDÆ.

UMBRACULUM, Schumacher, Essai Nouv. Test., 1817, p. 55.
1161—**umbella** Martyn, Lepas, Univ. Conch., 1786, pl. 102; O. indica, Angas, Proc. Zool. Soc., 1867, p. 228.

Suborder NUDIBRANCHIATA (1162–1201).

Family AEOLIDIADÆ.

CORYPHELLA, Gray, Fig. Moll. Anim., iv., 1850, p. 109.

1162—**foulisi** Angas, Æolis, Journ. de Conch., xii., 1864, p. 64, pl. 6, f. 3.

1163—**macleayi** Angas, op. cit., p. 65, pl. 6, f. 4.

Æolis cacaotica, Stimpson (Proc. Acad. Nat. Sci. Philad., vii., 1856, p. 388) has not again been recognised.

RIZZOLIA, Trinchese, Rend. Acad. Bologna, 1877, p. 62.

1164—**australis** Bergh, Chall. Zool., x., 1884, p. 27, pl. 9, f. 1–5.

FLABELLINA, Cuvier, Regn. Anim., 1849, 3 Ed., Expl. to pl. 30, bis. f. 2.

1165—**ianthina** Angas, op. cit., p. 66, pl. 6, f. 6.

1166—**newcombi** Angas, op. cit., p. 68, pl. 6, f. 8.

1167—**ornata** Angas, op. cit., p. 67, pl. 6, f. 7.

FIONA, Alder & Hancock, in Forbes and Hanley, Brit. Moll., 1853, p. x. footnote.

1168—**marina** Forskal, Limax, Descr. Anim., 1775, p. 99; Basedow & Hedley, Trans. Roy. Soc. S.A., xxix., 1905, p. 136.

GLAUCILLA, Bergh, Dansk. Vidensk. Selsk. Skrift. (5), vii., 1867, p. 105.

1169—**atlantica** Forster, Glaucus, Voy. Resolution, 1777, p. 49; Basedow & Hedley, Trans. Roy. Soc. S.A., xxix., 1905, p. 136.

JANUS, Verany, Rev. Zool., 1844, p. 302.

1170—**sanguineus** Angas, op. cit., p. 63, pl. 6, f. 5; Basedow & Hedley, op. cit., p. 137.

DOTO, Oken, Lehrb. Naturg., iii., 1815, p. 278.

1171—**australis** Angas, Melibæa, op. cit., p. 62, pl. 6, f. 2.

Family BORNELLIDÆ.

BORNELLA, Gray, Fig. Moll. Anim., iv., 1850, p. 107.

1172—**adamsi** Gray, op. cit., p. 107, pl. 196, f. 6; B. hermanni, Angas, op. cit., p. 61, pl. 6, f. 1.

Family PLEUROPHYLLIDIADÆ.

PLEUROPHYLLIDIA, Meckel, Archiv. Anat. & Physiol., viii., 1823, p. 190.

1173—**cygnea** Bergh, Malak. Blatt., xxiii., 1876, p. 9, pl. 1, f. 1–7; Basedow & Hedley, op. cit., p. 138, pl. 10, 11, 12.

Family DORIDIDÆ.

HEXABRANCHUS, Ehrenberg, Symb. Phys. Anim., 1831.

1174—**flammulatus** Quoy & Gaim., Doris, Zool. Astrolabe, ii., 1833, p. 257, pl. 17, f. 6–10; Basedow & Hedley, op. cit., p. 139.

ASTERONOTUS, Ehrenberg, Sym. Phys. Anim., 1831.

1175—**mabilla** Abraham, Proc. Zool. Soc., 1877, p. 249, pl. 28, f. 1–4.

HYPSELODORIS, Stimpson, Proc. Acad. Nat. Sci. Philad., vii., 1855, p. 388.

1176—**obscura** Stimpson, loc. cit., p. 388; Goniodoris crossei, Angas, Journ. de Conch., xii., 1864, p. 54, pl. 5, f. 1.

CHROMODORIS, Alder & Hancock, Monogr. Brit. Nud. Moll., Pt. vi., 1854.

1177—**bennetti** Angas, Goniodoris, Journ. de Conch., xii., 1864, p. 51, pl. 4, f. 10.

1178—**erinacea** Crosse, Goniodoris, op. cit., p. 57, pl. 5, f. 5.

1179—**daphne** Angas, op. cit., p. 54, pl. 5, f. 3.

1180—**festiva** Angas, op. cit., p. 53, pl. 4, f. 12.

1181—**loringi** Angas, op. cit., p. 52, pl. 4, f. 11.

1182—**runcinata** Bergh, Reis. Arch. Philipp., ii., 1877, p. 479–81, pl. 51, f. 32–33.

1183—**splendida** Angas, op. cit., p. 55, pl. 5, f. 2.

1184—**verrucosa** Crosse, op. cit., p. 56, pl. 5, f. 4.

CASELLA, H. & A. Adams, Gen. Rec. Moll., ii., 1858, p. 57.

1185—**atromarginata** Cuvier, Doris, Ann. Mus., iv., 1804, p. 473, pl. 2, f. 6; Bergh, Siboga Opisthobranchiata, 1905, p. 162, pl. 2, f. 8; Basedow & Hedley, Trans. Roy. Soc. S.A., xxix., 1905, p. 142.

CERATOSOMA, Adams & Reeve, Samarang Zool., 1848, p. 67.

1186—**brevicaudatum** Abraham, Ann. Mag. Nat. Hist. (4), xviii., 1876, p. 142, pl. 8, f. 6; Basedow & Hedley, Trans. Roy. Soc. S.A., xxix., 1905, p. 143, pl. 1.

Family DORIOPSIDÆ.

DORIOPSIS, Pease, Proc. Zool. Soc., 1860, p. 32.

1187—**aurea** Quoy & Gaim., Doris, Astrolabe Zool., ii, 1833, p. 265, pl. 19, f. 4–7; Basedow & Hedley, op. cit., p. 145, pl. 7, f. 4.

1188—**australiensis** Abraham, Proc. Zool. Soc., 1877, p. 243, pl. 30, f. 25, 26.

1189—**australis** Angas, Actinodoris, Journ. de Conch., xii., 1867, p. 49, pl. 4, fig. 8.

1190—**carneola** Angas, Doris, op. cit., p. 48, pl. 4, f. 7; Basedow & Hedley, op. cit., p. 157, pl. 6, f. 1, 2.

1191—**denisoni** Angas, op. cit., p. 45, pl. 4, f. 2.

1192—**nodulosa** Angas, op. cit., p. 48, pl. 4, f. 6.

1193—**pantherina** Angas, op. cit., p. 47, pl. 4, f. 5.

1194—**violacea** Quoy & Gaim., Doris, Astrolabe Zool., ii., 1833, p. 264, pl. 19, f. 1–3.

Family POLYCERIIDÆ.

TRIOPA, Johnston, Ann. Nat. Hist., i., 1838, p. 123.

1195—**yatesi** Angas, op. cit., p. 60, pl. 5, f. 8.

PALIO, Gray, Guide Brit. Mus., 1857, p. 213.

1196—**cooki** Angas, Polycera, op. cit., p. 58, pl. 5, f. 6.

ANGASIELLA, Crosse, Journ. de Conch., xii., 1864, p. 50.

1197—**edwardsi** Angas, op. cit., p. 49, pl. 4, f. 9.

PLACAMOPHERUS, Leuckart in Ruppel Reise Nord Afrika, 1828, p. 17.

1198—**imperialis** Angas, op. cit., p. 59, pl. 5, f. 7.

Family ELYSIIDÆ.

ELYSIA, Risso, Journ. de Phys., lxxxvii., 1818, p. 376.

1199—**australis** Quoy & Gaim., Actæon, Astrolabe Zool., ii., 1833, p. 317, pl. 24, f. 18–20; E. coogeensis, Angas, op. cit., p. 69, pl. 6, f. 9.

Nudibranchs of Uncertain Position.

1200—**Doris arbutus** Angas, op. cit., p. 47, pl. 4, f. 4.

1201—**Doris chrysoderma** Angas, op. cit., p. 46, pl. 4, f. 3.

Doris obtusa Stimpson, Proc. Acad. Nat. Sci. Philad., vii., 1855, p. 389.

This species has not been figured, the type is lost, and it may therefore be discarded as unrecognisable.

Doris excavata Stimpson, op. cit., p. 389, ditto.

Class SCAPHOPODA (1202 – 1208).

DENTALIUM, Linné, Syst. Nat., x., 1758, p. 785.

1202—**erectum** Sowerby, Thes. Conch., iii., 1860, p. 99, pl. 225, f. 55.

1203—**lubricatum** Sowerby, op. cit., p. 97, pl. 225, f. 56; Verco, Trans. Roy. Soc. S.A., xxxv., 1911, p. 210, pl. 26, f. 4.

1204—**platyceras** Sharp & Pilsbry, Man. Conch., xvii., 1898, p. 126, pl. 22, f. 58–60.

1205—**thetidis** Hedley, Mem. Austr. Mus., iv., 1903, p. 327, f. 61.

1206—**virgula** Hedley, op. cit., p. 328, f. 62; May, Proc. Roy. Soc. Tasm., 1915, p. 79.

E. A. Smith has erroneously recorded (Proc. Malac Soc., i., 1894, p. 60) D. capillosum, Jeff., D. ensiculus, Jeff., and D. panormitanum, Chenu, from 410 fathoms off Sydney.

CADULUS, Philippi, Moll. Sicil., ii., 1844, p. 208.

1207—**acuminatus** Tate, Proc. Roy. Soc. S.A., ix., 1887, p. 194; Verco, Trans. Roy. Soc. S.A., xxviii., 1904, p. 138, pl. 26, f. 1–6.

1208—**spretus** Tate & May, Trans. Roy. Soc. S.A., xxiv., 1900, p. 102; Hedley, Mem. Austr. Mus., iv., 1903, p. 328.

Smith has erroneously recorded (Proc. Malac. Soc., i., 1894, p. 60) Cadulus propinquus, Sars, from 410 fathoms off Sydney.

Sub-Kingdom BRACHIOPODA.

Family LINGULIDÆ.

LINGULA, Bruguiére, Encycl. Meth. vers., 1789, Expl., pl. 250.

1—**rostrum** Shaw, Mytilus, Nat. Miscell., ix., 1797, pl. 315; Hedley, P.L.S.N.S.W., xli., 1917, p. 694.

Family CRANIIDÆ.

CRANIA, Retzius, Schrift. Ges. Fr. Berlin, ii., 1781, p. 66.

2—**suessi** Reeve, Conch. Icon., xiii., 1862, pl. 1, f. 2.

Family RHYNCHONELLIDÆ.

CRYPTOPORA, Jeffreys, Nature, Dec., 1869, p. 136.

3—**brazieri** Crane, Atretia, Trans. Linn. Soc., iv., 1887, p. 175, pl. 25, f. 16–17; Hedley, P.L.S.N.S.W., xxxi., 1906, p. 467, pl. 36, f. 1, 2.

ÆTHEIA, Thomson, Geolog. Mag., Sept., 1915, p. 389.

4—**columnus** Hedley, Hemithyris, Rec. Austr. Mus., vi., 1905, p. 44, f. 7, 8.

Family TEREBRATULIDÆ.

TEREBRATULINA, D'Orbigny, Compt. Rend. Acad., xxv., 1847, p. 268.

5—**cancellata** Koch, Conch. Cab., vii., 1843, p. 35, pl. 26, b., f. 11–13.

6—**radula** Hedley, P.L.S.N.S.W., xxix., 1904, p. 209, pl. 10, f. 48–50.

LYOTHYRELLA, Thomson, Trans. N.Z. Inst., xlviii., 1916, p. 44; Jackson, Geolog. Mag. n.s. (6), v., 1918, p. 73.

7—**fulva** Blochman, Lyothrina, Zool. Anz., xxx., 1906, p. 698, and Proc. Roy. Soc. Tasm., 1913, p. 112, pls. 10, 12.

Family TEREBRATELLIDÆ.

MEGERLINA, Deslongchamps, Bull. Soc. Linn. Normand. (2), viii., 1884, p. 159.

8—**lamarckiana** Davidson, Kraussia, Proc. Zool. Soc., 1852 (1854), p. 80, pl. 14, f. 22, 23; Gatliff & Gabriel, Vict. Nat., xxx., 1914, p. 213.

CAMPAGES, Hedley, Rec. Austr. Mus., vi., 1905, p. 43.

9—**furcifera** Hedley, op. cit., p. 43, f. 5, 6; Thomson, Geol. Mag., Nov., 1916, p. 500.

10—**jaffænsis** Blochman, Magasella, Trans. Roy. Soc. S.A., xxxiv., 1910, p. 92, pl. 27, f. 6–9; Hedley, Endeavour Biolog. Result., 1911, p. 114, pl. 20, f. 41–42.

MAGELLANIA, Bayle, Journ. de Conch., xxviii., 1880, p. 240.

11—**flavescens** Lamarck, Terebratula, An. s. vert., vi., 1819, p. 246; Davidson, Trans. Linn. Soc., iv., 1886, p. 41, pl. 7, f. 6–9.

MAGADINA, Thomson, Trans. N.Z. Inst., xlviii., 1915, p. 399.

12—**cumingii** Davidson, Terebratella, Ann. Mag. Nat. Hist. (2), ix., 1852, p. 368, and Trans. Linn. Soc. (2), iv., Zool., 1887, p. 97, pl. 17, f. 23–32.

FRENULINA, Dall, Proc. U.S. Museum, xvii., 1894, p. 724.

13—**pulchella** Sowerby, Terebratula, Thes. Conch., i., 1844, p. 360, pl. 71, f. 105–7; Brazier, Journ. of Conch., vi., 1889, p. 82.

14—**sanguinolenta** Gmelin, Anomia, Syst. Nat., xiii., 1791, p. 3347; Davidson, Trans. Linn. Soc., iv., Zool., 1887, p. 108, pl. 20, f. 1–8.

ALDINGIA, Thomson, Geol. Mag., Nov., 1916, p. 501.

15—**willemoesi** Davidson, Megerlia, Trans. Linn. Soc. Zool. (2), iv., 1887, p. 111, pl. 19, f. 23–26.

In error, Terebratula pisum has been recorded by Sowerby (Thes. Conch., i., 1844, p. 345) from Sydney; Liothyris uva by Davidson (Chall. Zool., i., 1880, p. 31) from Twofold Bay; and Megerlia truncata by Dall (Am. Journ. Conch., vi., 1871, p. 130) from Sydney.

New Names are proposed in this publication as follows:

Generic:—Attenuata, Austrodrillia, Epideira, Etrema, Exomilus, Guraleus, Inquisitor, Hemidaphne, Macteola, Nepotilla, Provexillum, Scabrella.

Specific:—Anabathron contabulatum lene, Pseudarcopagia botanica, Asthenotoma subtilinea, Bullaria botanica, Daphnella botanica, Gomphina fulgida, Trivia caelatura, Lepsiella botanica, Myrtaea botanica.

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